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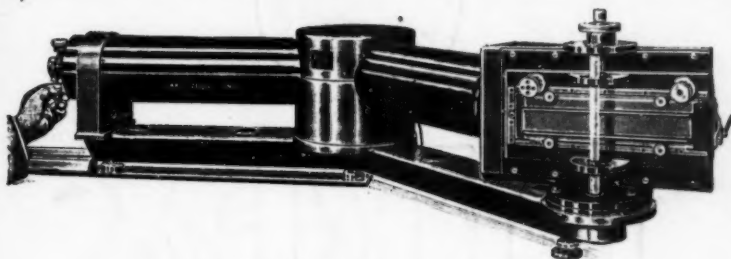
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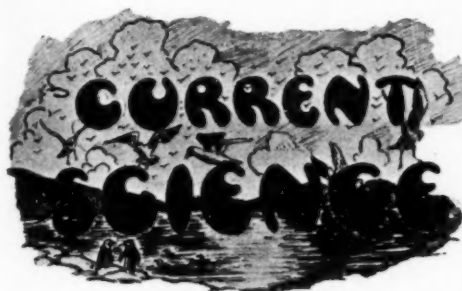
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### Our City Streets.

FEW will doubt the fact that the average man in the present age enjoys greater comforts and a distinctly higher standard of life than his predecessors in the past. Generally speaking, science has made it abundantly possible to prolong human life which is now less subject to disease, and its discoveries have been used to place amusements and light instruction practically within the reach of all. Transport has now become rapid and fairly safe, and the increasing appreciation of such amenities by the public supports huge industries, which provide employment both for skilled and unskilled labour. But it is equally manifest that the mechanical inventions which have rendered all these things possible have also introduced certain grave and objectionable features into our lives. It must be remembered that every material device, which distinguishes the present age from the last, is invariably noisy and sometimes even fraught with danger to the public when incautiously handled.

The streets and roads in Indian cities are becoming noisier every year, but there is still no general complaint that the noises have begun to affect human nerves and health. In India the street noises are comparatively a milder nuisance, but the danger to public health, produced by the insanitary conditions of the streets and the dust raised by the fast-moving vehicles, is always grave, and is not mitigated though most of the principal thoroughfares are asphalted. Indian towns and cities which were built in ancient times satisfy neither the principles of modern town planning nor the hygienic requirements of efficient and healthful urban life. The chief concern of the early builders was obviously to ensure protection for the towns against the aggressions of invaders, and with this object the houses were built contiguously and the roads were purposely made narrow and tortuous. In the early centuries when public life in India was frequently disturbed by the conflicts of rival parvenu chieftains, the mortal anxiety of the people was to protect their person and property in thick mud houses with small doors and smaller windows, and all built as near to each other as possible. Whether this mode of defence secured immunity from the raids of lawless criminals and freebooters might be doubted, but it is certain

that these types of buildings which effectually shut out air and light, laid the foundation of recurring epidemic diseases. The establishment of peace and security in the country under the British Rule has stimulated the expansion of trade and favoured the rapid multiplication of population, but till recently it has not affected the physical structure of towns and cities. The European community, which lived beyond the city limits from the time of Company Administration, could hardly visualise the unsatisfactory conditions under which the native population flourished, and even to-day the administrators of the country have only a vague apprehension of the squalor and maladies which afflict the extremely insanitary and congested quarters in the heart of towns. The intention underlying the transfer of municipal administration to local self-governing bodies is certainly entitled to praise, but the successful accomplishment of the task confronting the municipal commissions demanded knowledge, training, experience, imagination and financial resources which the councillors did not possess. In spite of such inadequate equipment, Indian municipalities have done a great deal towards improving the conditions of areas in their jurisdiction, but if more has not been done it is not their fault. The civic population has to co-operate and appreciate the efforts of municipalities in securing the amenities which make life enjoyable.

The introduction of motor cars, buses, lorries and trams into Indian cities without previously replanning them to receive these fast-moving vehicles, must naturally be attended by danger to public safety. This danger is two-fold. Modern traffic in the cities and towns has created a new environment to which the Indian population was not accustomed, and adaptation to it must be a question of time and long usage. The users of these new types of powerful automobiles only see in them machines made to give them comfort and speed, and hardly realise the potential damage they are capable of inflicting on the unwary public. Accidents under such conditions are bound to occur. Till the use of motors became general, the dust problem of large cities and towns used to assume menacing proportions only periodically just about the months when heavy winds continually swept over them, bringing in their train all manner of diseases. The recent preparation of certain roads for motor traffic has not, however, abated the acute-

ness of the problem, but on the other hand the trouble has become more or less chronic. The tarred roads are always covered by a thin or thick layer of dust according to weather conditions; and the droppings of stray animals and the human defilement of streets and roads constitute a source of perpetual danger to public health. The unfortunate pedestrians are practically compelled to inhale the air heavily charged with them when disturbed by the passing cars, buses and trucks. What with the congestion in the towns and a continuous shower of unhealthy dust raised throughout the day, it is no wonder that the public health of large cities and towns is unsatisfactory all the year round. If every citizen will only take the minimum trouble, he has the means of protecting himself and his family from the dangers arising from dust on the one hand and from accidents on the other.

Almost every Hindu household in India used to observe till recently the custom, amounting almost to a religious practice, of washing with water the section of the road immediately in front of the principal door, both in the morning and in the evening, and to decorate the washed portion with elaborate decorative patterns with rice flour or quartz powder. The practice at one time was so general that even traders and merchants used to sprinkle the roads in front of their shops with water. This simple practice which was universal had the desired effect of mitigating the dust nuisance and cooling the air, but it has now almost disappeared. If it could be revived and the washing of the street could, with charity, be extended to the limits of the neighbouring houses, real public service of immense hygienic value would be rendered by every household, and the sanitation of the whole town would thus easily be secured, at least in part. The habit of throwing into the open streets offal and other rubbish, and the commission of nuisance in the close proximity of residential places at night and sometimes during the daytime as well, have developed recently to a tormenting pitch, and this is almost entirely due to the fact that the sense of decency and a correct knowledge of the harm done to public health by such acts do not form part of the mental equipment of the average citizen. People have to realise that these acts are deadly sins whose effects are visited on the residents of the whole street, and, that food thrown into



other hand, less chronic. covered by droppings of filth of a source of health. The practically air heavily disturbed by. What with and a continued through- at the public is unsatis- every citizen ble, he has self and his g from dust dents on the

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This simple and the desired nuisance and y almost dis- ved and the with charity, ne neighbour- of immense red by every of the whole red, at least ing into the rubbish, and in the close at night and as well, have enting pitch. e to the fact correct know- lic health by f the mental ized. People s are deadl the residents d thrown into

the drains supports the unwanted population of stray animals which contaminate the surroundings, besides being a nuisance in other ways. A street reeking with evil smell and full of fermenting heaps of rubbish must necessarily make life intolerable, and ultimately destroy aesthetic sense. Disposal of city refuse must, at all times, be a big problem for municipalities, but if every house sets apart a place where it is burned every day the hygienic condition of the street is easily and automatically secured. This must eventually lead to the diminution of the numbers of stray animals, and if simultaneously the beggar problem is solved by the combined efforts of the Municipalities and Government the dust on the city streets will undoubtedly become less offensive and dangerous. It is a duty which every citizen owes to himself and to the community at large to keep his premises absolutely sanitary, and it is almost fatal to suppose that it is his privilege to defile the streets and that it is the work of the municipality to tidy things for him. Every sanitary offence committed is an offence against humanity.

Schools and colleges have to develop this municipal sense in the minds of the younger generation. Large factories and business organisations which employ numerous workmen should insist on the strict observance of sanitary rules by the mill hands. The police constables on traffic duty and others whether in uniform or mufti should be warned to keep an eye on likely offenders, and the health officers of municipal corporations should be extremely vigilant in the exercise of the powers vested in them to prosecute people misconducting themselves from the viewpoint of decency and public health. But every one of these preventive and punishable measures can be evaded by the people if they choose, and if they are not deeply convinced that the health and the well-being of the town are their own making. If by a determined effort every householder in the town were to take measures calculated to keep his premises clean and wholesome, then he has a right to ask for protection against the noise and accidents due to reckless and negligent motor traction.

It is true that the volume of motor traffic in Indian cities has not assumed alarming proportions, but already the noise from this source is as acutely disturbing to the nerves as its speed is causing anxiety for public safety. Noise is to a large extent a subjec-

tive phenomenon, and reaction to it must be temperamental. Responsible medical opinion is agreed that, in general, noise is bound to produce serious effects, especially in the case of mental workers, young children, the nervous, the fatigued and the sick. The investigations of the Industrial Health Research Board in Britain have obtained conclusive results in regard to the effect of noise on industrial output. We cannot accept the statement usually made that the human system may become so accustomed to noise that we may cease to regard it as a nuisance. Noise is always distracting and may even become nerve-racking. It is a real menace to the efficiency of labour in every field, and the public is entitled to demand protection. In Indian towns and cities the road noises are bound to become troublesome in view of the peculiar type of structural material employed in the building of houses which are generally continuous. To judge by the evidence obtained by the National Physical Laboratory, the structure-borne disturbances travel to the buildings from the source for great distances, manifesting themselves on meeting resonant walls and rooms. Indian homes built on the old style, by their position with regard to each other in the same row and to those on the opposite, seem to be exquisitely adapted to receive every kind of noise and transmit it to the contiguous and opposite structures. Street noise has always been one of the minor horrors of Indian life, which, through ages of its insidious influence, has slowly undermined the physical and mental efficiency of the general public; and the problem assumes a grave aspect in view of the aggravating causes introduced by motor traffic.

The statistics of mortalities, published periodically by the Ministry of Transport, due to motor accidents even in European cities which have been replanned for this new mode of locomotion, and where generally people are alive to the dangers of indolence on the roads, must cause grave anxiety; and in the streets of Indian towns which are narrow and full of ruts and pot holes, and in which people move both slowly and incautiously, automobiles are capable of inflicting greater damage. The causes which are capable of producing accidents in India are far more numerous than in any country in Europe or America. The streets teem with a variety of stray animals which sometimes effectually barricade the road, and some of them have an inveterate habit of going off to

sleep right in the centre of thoroughfares. On account of the extremely congested quarters, children make use of the streets as their playground, and they generally become reckless to traffic conditions in their enthusiasm to pursue their games. School boys and college students ride their bicycles four or five abreast or walk in large bunches absorbed in discussing metaphysical problems, and totally oblivious of the traffic dangers through which they are passing. Vendors, hawkers and beggars, generally blind and defective in other respects also, are always in evidence tending to augment the general confusion. People from the villages, ignorant of traffic rules and intent more on admiring the interesting sights of cities which they visit occasionally, than on protecting their persons, are a grave menace to motor traffic. The vehicles drawn by animals such as bullocks and horses which ply on the narrow streets, are another cause of frequent accidents. In the larger cities like Calcutta, Bombay and Madras traffic has gradually come under the control of the police, but in the towns the offending public is prone to discuss matters with the traffic directors.

Motorists are not saints. The greatest danger to pedestrian traffic arises from nervous drivers and young people in charge of the wheel. The nervous motorist is always caught between two minds as much as the confused pedestrian in a critical situation, and the youthful drivers do not recognise the fact that spare parts of the human body are not procurable. The number of motor vehicles on the Indian streets and roads has not yet reached saturation point, but nevertheless the annual increase of cars, buses and trucks must directly aggravate the menace to public safety and well-being, unless steps are taken to protect the people.

It seems to us that the Road problems both in their magnitude and importance are sufficiently complex and serious to warrant the creation of a Ministry of Transport in

each Province to deal with every aspect of traffic. These problems are at once scientific and psychological. The existing practice of dealing with them partly through the police department and partly through the municipalities must be empirical. This new Ministry of Transport must be attached to the Noise Abatement Commission and the Industrial Health Research Board, staffed by physicists, psychologists, physicians, lawyers and engineers. It may be said that proposals of this nature are premature, because in Indian cities the problem is not so serious as in London, New York, Paris and Berlin, but the level of noise and accidents is bound to rise year by year, and wise statesmanship should not wait till the torment becomes ungovernable.

The efforts of Government alone will not be adequate to grapple with the road problems, and the co-operation of the people is indispensable for their satisfactory solution. Every town should have a People's Health League for securing protection of the public against noise, dust and accidents. The league when established might find it advantageous to work in collaboration with the educational institutions. It is the younger generation who stand in most need of imbibing the principles of public health and cultivating road courtesy and a cheerful adherence to law. It ought to be the imperative duty of Scout and Rover corps to utilise every opportunity of assisting the deformed beggars and unsophisticated village folk whenever, either out of ignorance or incapacity, they trespass the rules of traffic. Every member of the Health League and all the Scouts and Rovers should be invested with power by Government to bring to justice offenders of traffic regulations and public decency. A clean and wholesome street implies sweet and hygienic homes and both are an insurance against epidemic diseases. The task of fighting them is largely in the hands of the people themselves.

### "Physica."

THE new Dutch Scientific Journal *Physica* has entered upon its second year and we have received the first number of the second volume of this valuable publication. It was started with the object of giving greater publicity to the work of Dutch physicists

and the articles are published in English, French or German. The Board of Editors consists of such well-known physicists as P. Zeeman, D. Coster, W. J. de Haas, W. H. Keesom, I. S. Ornstein and H. A. Kramers. As is to be expected from such a list of names,

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the articles appearing in the Journal are of great importance and interest. Particular interest attaches to the results obtained in the cryogenic laboratory in Leyden, the measurements of intensities of spectral lines initiated by Ornstein and the X-ray studies of D. Coster and his pupils. In the issue before us we have accounts of X-ray studies from D. Coster's laboratory and of

low temperature research carried out at Leyden. The Utrecht School is also represented. J. P. Schouten has an interesting note on a theorem in the operational calculus. We may confidently say that the high standard reached will be kept up in succeeding numbers. We wish the Journal a long and useful life.

### Frost Hazard in India.

By L. A. Ramdas, M.A., Ph.D.,  
*Meteorological Office, Poona.*

THE farmer knows how dependent his crops are on weather conditions. A good yield is dependent, amongst several factors, upon a sufficient quantity of rain, suitably distributed, during the growing season, as well as upon a favourable sequence of air temperature, humidity, soil temperature, etc. Experience tells us that there are optimum values for these factors and that excessive rain or drought, intensely hot or cold waves, extremes of humidity or dryness, are all equally dangerous to a growing crop. In the present note we shall confine our attention to the adverse effects\* of cold waves in India and the frosts which occur during their incidence.

It may be pointed out that the phenomenon of frost is essentially a radiation† phenomenon during clear nights and occurs about the epoch of minimum temperature. In lower latitudes like ours the soil is usually warmer than the air layer above it so that the latter has to cool by radiation to the colder air masses in the upper atmosphere. If there is air movement at night the stratification due to radiative cooling is upset with the result that the air temperature will not fall as rapidly as when the air is stationary. During winter at most places the mean air temperature at sunset is too high for nocturnal cooling even during

favourable nights to cause frost on the next morning. This is, however, possible on days when the temperature at sunset is sufficiently low, e.g., when the country is invaded by a cold wave from the north.

The northern parts of India are visited by cold waves during winter. The cold waves usually come in the wake of the western depressions which enter India, at intervals of about a week across the north-west frontier and Baluchistan and move eastwards through the Indo-Gangetic plain towards the north-east frontier of India. The origin and structure of the winter depressions have been the subjects of many investigations, notable contributions having been made by Hemraj,<sup>1</sup> Walker and Kameswara Rao,<sup>2</sup> and recently by Banerji.<sup>3</sup> It is now an established fact that the winter depressions which invade India are associated with the family of depressions which originate at the partition in the Atlantic regions between the warm and moist equatorial air and the cold air of the higher latitudes.

The approach of a winter depression is heralded in North India by the appearance of high clouds, and the rise of air temperature associated with air movement from the south. Later, the clouds lower and drizzling weather ensues. So long as a place lies in this "warm" sector of a depression there is no likelihood of a conspicuous fall in temperature. The passage of the "warm" sector eastwards is followed, however, by the "cold wave" during which northerly

\* For two interesting accounts of the damage to crops during frost please see Bulletin No. 165 of 1930 by K. V. Joshi, Department of Agriculture, Bombay, and an article on "The Effect of Frost on some crops at Pusa" by R. D. Bose, *Agriculture and Live-stock in India*, 1933, 3, 555.

† The loss of heat by radiation experienced by a layer of air during the night depends upon the amount and distribution of water vapour in the atmosphere. This problem is being discussed in a forthcoming paper.

<sup>1</sup> *Indian Meteorological Memoirs*, 21, Part 7.

<sup>2</sup> *Ibid.*, 24, Part 2.

<sup>3</sup> *Meteorology of the Persian Gulf and Mekran*, by B. N. Banerji; special brochure published by the Indian Meteorological Department.

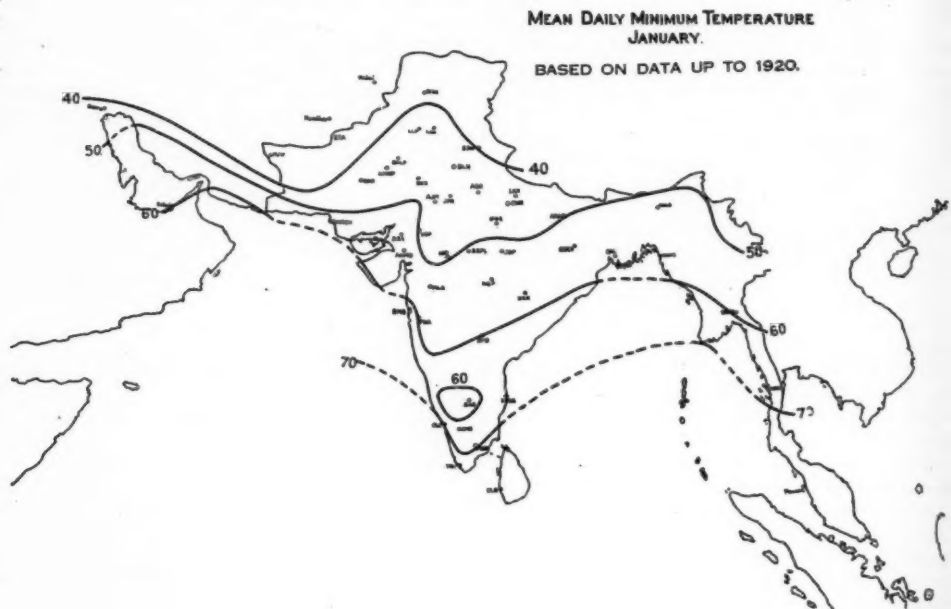


Fig. 1.

cold winds pour into the country. The cold wave in its turn extends or moves eastwards across the country, weakening in the meantime. As soon as another western depression approaches the north-west frontier the temperature begins to rise rapidly.

The intensity of a cold wave as well as the extent of the country which it affects depend upon a number of factors, *e.g.*, the intensity and area of the depression with which it is associated. Sometimes, the anti-cyclone over Tibet and Mongolia which is the main reservoir of cold air for Asia is itself shifted westwards towards Europe, and if at the same time a deep western depression passes through Persia and North-West India, a very severe cold wave sets in behind the depression. The phenomenal cold wave which visited India during the period 30-1-1929 to 3-2-1929 was of this type.

In most years the cold waves affect only north-west India and the adjoining parts of Sind, Rajputana, the United Provinces, Central India and Gujarat. During unusually intense cold waves even the Bombay

Deccan is affected. The area to the south of latitude  $18^{\circ}$  N. is practically free from the adverse effects of the cold waves even on such occasions.

Fig. 1 shows the normal<sup>‡</sup> daily minimum temperature over India during the month of January as recorded inside the standard screen or shed. The normal shade minimum temperature is  $40^{\circ}$  F. and above, practically over the whole of India excepting the mountainous tracts to the north.

Fig. 2 shows the lowest minimum temperature in the shade recorded up to 1920. This chart indicates that in the region lying to the north of latitude  $18^{\circ}$  N. the minimum temperatures may sometimes fall by  $20^{\circ}$  F. below the normal for January whereas to the south of this latitude the lowest minimum temperatures are only about  $10^{\circ}$  F. below the normal.

It must be remembered, however, that the temperature recorded by a minimum thermometer inside a screen at 4 ft. will be higher than the temperature recorded by a similar instrument exposed to the sky and

<sup>‡</sup> Based on data up to 1920.



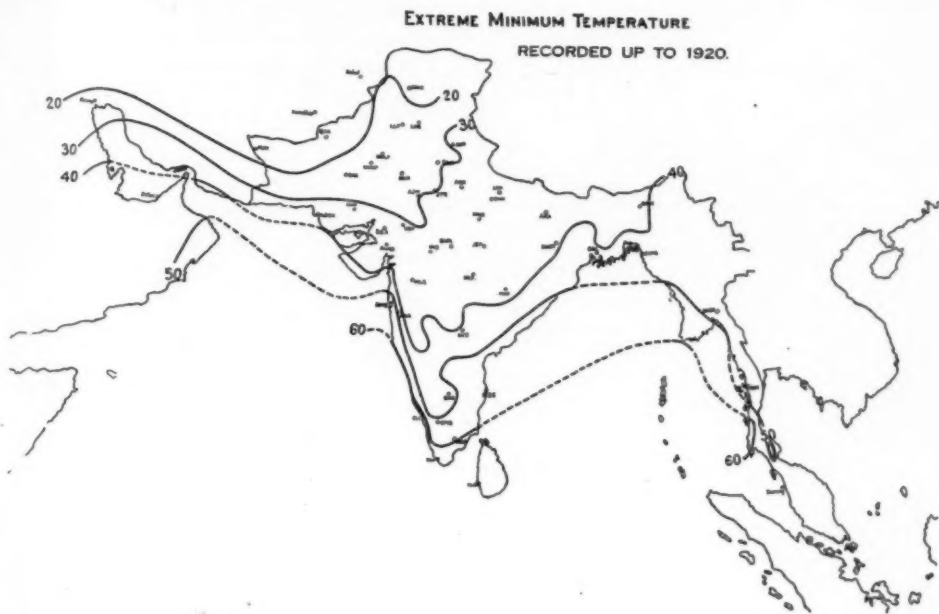


Fig. 2.

the ground surface. In studies on frost, we are concerned with the temperature attained during the night by objects near the ground which are exposed to the sky but which are thermally insulated from the soil. Such bodies usually radiate out more heat energy than they receive from the sky or the ground or by contact with the surrounding air.

A measure of the lowering of the minimum temperature in the open near the soil surface below the minimum temperature inside the screen at 4 ft. can be had from the nocturnal radiation temperature measurements made at a few selected stations in India for a few years. Table I gives the depression of monthly mean nocturnal radiation (minimum) temperatures below the mean minimum shade temperatures for the month of January.

On an average the depression is of the order of  $10^{\circ}$  F. in the month of January. Using similar data for other months Mr. Ananthapadmanabha Rao has prepared charts of India showing the frequency of occasions when the minimum temperature in the open fell below certain limiting values (*viz.*, below  $34^{\circ}$  F.,  $32^{\circ}$  F.,  $30^{\circ}$  F.,  $28^{\circ}$  F.) during

TABLE I.

Name of Station	Mean depression $^{\circ}$ F	Name of Station	Mean depression $^{\circ}$ F
Murree	10.9	Sibsagar	5.2
Lahore	9.5	Nagpur	13.4
Ludhiana	10.1	Deesa	8.9
Jeypore	9.8	Bombay	10.1
Mount Abu	16.5	Poona	13.2
Ranikhet	13.6	Vizagapatam	11.8
Lucknow	8.7	Madras	3.9
Allahabad	11.4	Wellington	8.6
Hazaribag	9.9	Rangoon	7.4
Calcutta	9.2	Leh	11.8
Saugar Island	9.3	Aden	3.1
Dhubri	7.4		

the period 1920 to 1929. Fig. 3 shows the total number of occasions during this period when the minimum temperature in the open fell below  $30^{\circ}$  F. in different parts of India. From this chart it may be seen that the number of days in January when the minimum temperature in the open may be expected to fall below  $30^{\circ}$  F. will be roughly as given in Table II.



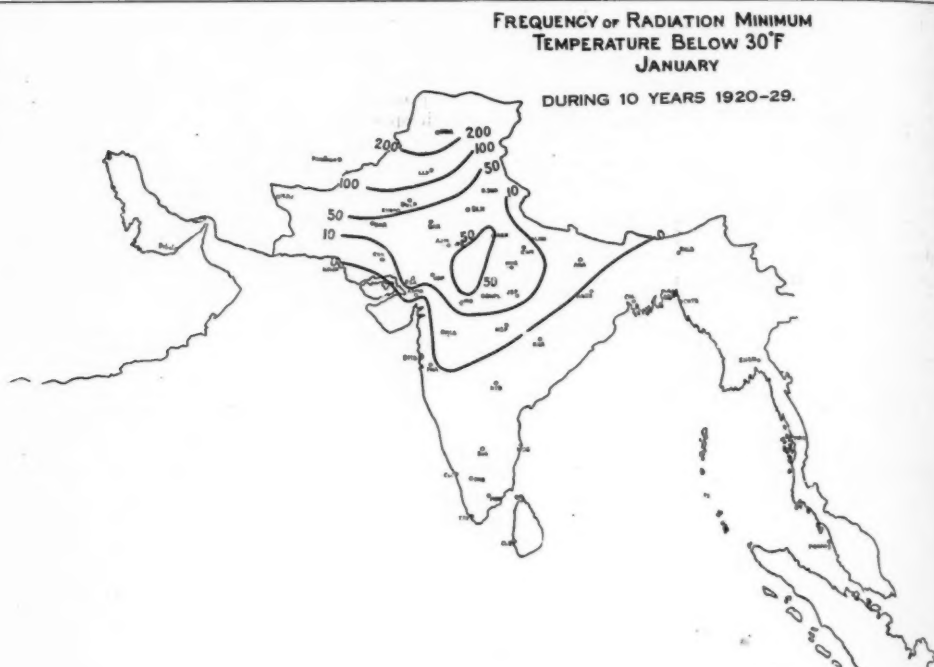


Fig. 3.

TABLE II.

Area	Number of days in the month of January when radiation minimum temperature is likely to fall below 30°F.
1. Kashmir and adjacent areas	20 days
2. Punjab (North)	10 to 20 days
3. Punjab (South)	5 to 10 days
4. Sind (excluding coastal tracts), Rajputana, Central India and West United Provinces.	1 to 5 days
5. Bombay Deccan, Northern portion of H.E.H. the Nizam's Dominions, East U.P., Bihar and a portion of North Bengal	0 to 1 day
6. Rest of Peninsula including the coastal districts of Sind, Kathiawar and the plains of Bengal	Nil

So far we have been considering the radiation minimum temperature 2 or 3° above the ground. The present writer and

his associates<sup>4,5</sup> have found that even at the minimum temperature epoch in winter the temperature of the bare soil surface is higher than that of the air in contact with it and that the lowest air temperature occurs at some height above the ground. This level is usually about 6" above the ground in the open and between 1 to 3 ft. above the ground inside crops, depending upon the plant population and height of the crop. The above results are obtained inside both irrigated and unirrigated crops. These temperature measurements were taken with the Assmann Psychrometer at the Agricultural Meteorological Observatory in the Agricultural College Farm, Poona, and refer to the air temperature. Radiation minimum temperatures taken with the help of 'radiation minimum thermometers' exposed at various heights above the ground are found

<sup>4</sup> Ramdas, L. A., and Atmanathan, S., *Gerlands Beitrage Zur Geophysik.*, 1932, **37**, 116-117.

<sup>5</sup> Ramdas, L. A., Kalamkar, R. J., and Gadre, K. M., *Indian Journal of Agricultural Science*, 1934, **4**, 451-467.

to be lower than the Assmann readings but they also behave similarly, i.e., the lowest temperature is recorded by the instrument kept a few inches above the ground and not the one nearest to the ground. Table III gives the mean values of the soil surface temperature (minimum) and the air temperatures (taken with an Assmann Psychrometer at the minimum temperature epoch) as well as the radiation minimum temperatures at different heights above ground for the month of January 1934.

TABLE III.

Height above ground	Air Temperature °F.	Radiation Minimum Temperature °F.
0 (soil surface)	51.2	51.2
0.4"	48.0	..
1"	47.1	44.2
3"	46.8	43.5
6"	46.8	43.9
1 ft.	46.9	44.1
3 ft.	48.6	44.5
The radiation minimum temperature over a grass plot, at a height of about 2' above the soil surface was only 41.8 °F.		

In the calculation of the means in the above table for the month of January 1934, a few cloudy days have also been included. On especially clear and calm nights the temperature contrast between the layer of coldest air and the air layers above and below it is much more pronounced. A few such instances are given in Table IV.

TABLE IV.

Height above ground	Air temperature in °F. at the minimum temperature epoch taken with an Assmann Psychrometer in January 1934 on					
	1	13	14	17	20	31
0.4"	44.8	36.0	33.8	40.1	46.0	37.0
1"	43.3	34.7	32.9	37.9	44.6	34.0
3"	43.0	34.0	32.0	37.2	43.7	33.8
6"	42.6	34.0	32.9	37.0	42.8	38.8
1 ft.	42.4	34.0	32.9	37.4	44.6	33.8
2 ft.	44.1	35.2	32.9	37.8	45.7	35.4
3 ft.	45.0	35.6	33.8	40.5	46.4	37.4
4 ft.	45.5	35.8	35.2	41.7	47.7	37.4
	Frost observed.					

# COLD WAVE WARNINGS AND PROTECTIVE MEASURES.

From the daily weather charts it is generally possible to give prior warnings for the incidence of cold waves. Such warnings were issued by the Forecasting Section of the Meteorological Office at Poona, to Mr. K. V. Joshi, Deputy Director of Agriculture, Nasik, well in advance of the cold waves which affected his area both during January 1934 and 1935. Mr. Joshi had made arrangements to disseminate the warnings promptly. The grape-growers of this district are reported to have appreciated these warnings as they could attempt to take some precautions to safeguard their crops.

The series of charts in Fig. 4 show the departure of the mean temperature of day from normal for the period 13th to 20th January 1935. The passage of the cold wave through the country (this was associated as usually with a western depression) is well illustrated by these diagrams. It will be noticed that the departures from the normal were up to 16° F. after the wave entered India.

Besides disseminating the warnings it is also important to tell the cultivator how best he may take advantage of them. Although suggestions for protective measures had been made it was found that the measures taken by the grape-growers were very inadequate to resist the damaging effects of the cold wave this year. Some farmers had a few dull and smoky fires lit up at the fringes of the garden and these had very little effect even in their immediate neighbourhood on account of the wind. The effect of irrigation has not been found to be significantly beneficial this year. Wind breaks of jowar stalks were found to be of no use. One or two grape gardens which escaped with light damage had apparently the natural advantage of road-side avenues (which served as wind breaks) or of higher elevation or of slopes where cold air will not stagnate.

The whole problem of frost prevention inside crops is one which awaits further experimental work so far as its practical aspects under Indian conditions are concerned. At present we have no working knowledge of the measures that may be economically adopted for the prevention of frost-damage in India.

The main steps in any attempts to conserve heat inside gardens are:—

(1) Prevention of air movement: during intense cold waves in winter there is fairly strong air movement near the ground, especially during the initial period; protective measures like fires will not be effective unless the air movement is checked by an adequate system of wind breaks.

(2) Burning *bright* fires in adequate numbers: they should be uniformly distributed inside the garden; to afford protection to marginal plants there should

an extra line of fires at the outskirts of the garden.

The experience in the United States America, where a very large amount of work on protective measures against frost has been done is that other methods like irrigation or placing covers may afford temporary relief under mild and short spells of frost but are of little use during intense

Charts showing departure of mean temperature of day from normal from 13-1-1935 to 20-1-1935.

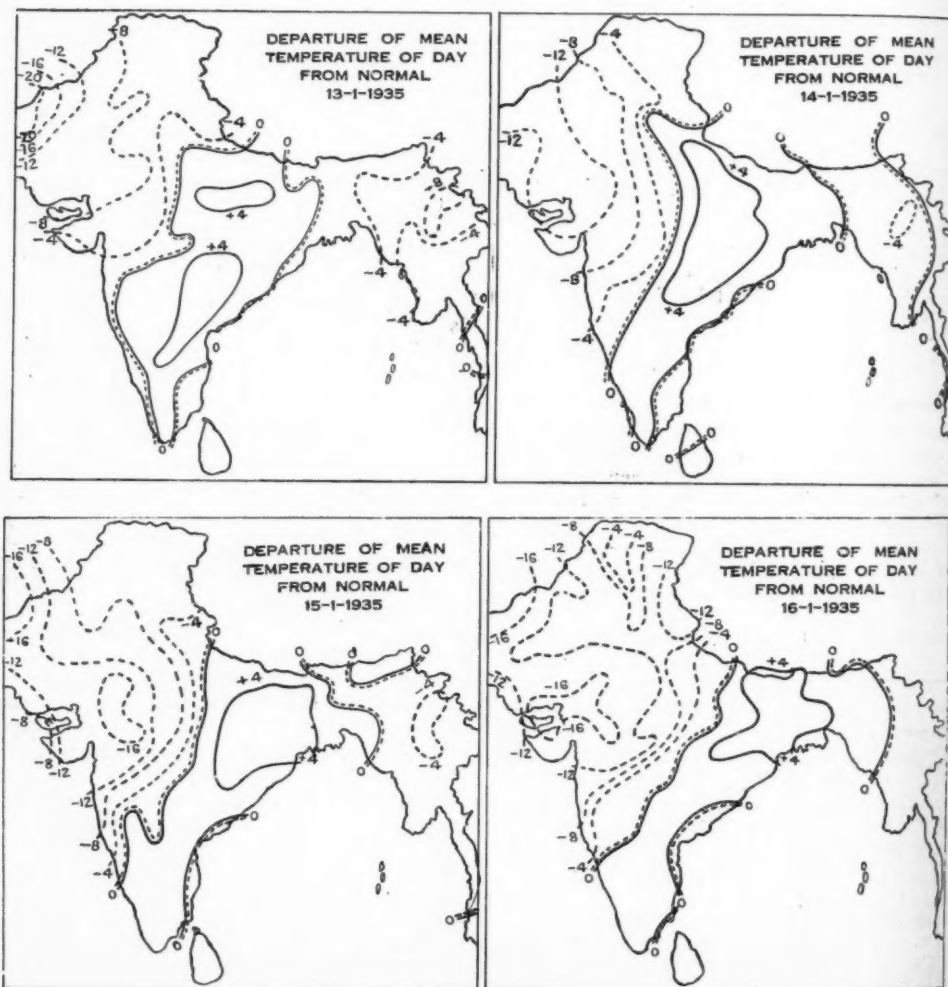


Fig. 4.

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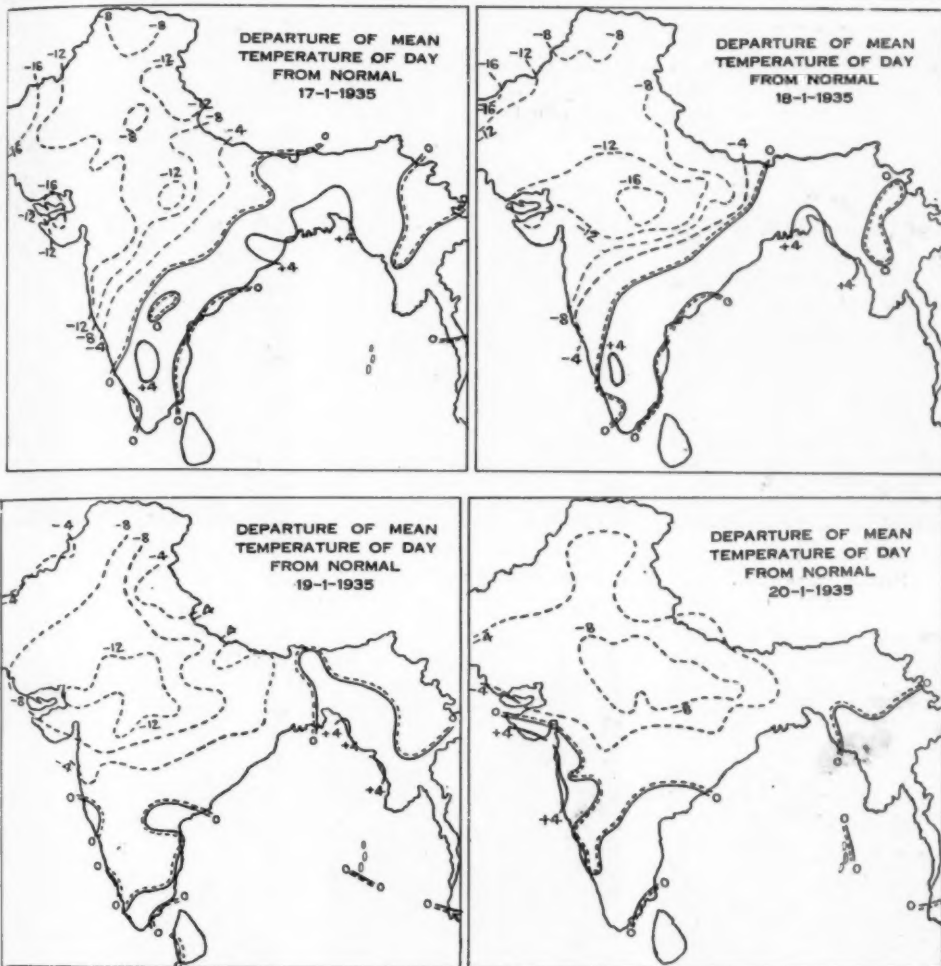


Fig. 4.—(Contd.)

frosts lasting for a few days, like the one which was experienced recently in many parts of North-West India, Gujarat and the Bombay Deccan.

The actual extent and distribution of the damage to different crops are being ascertained and the writer hopes to discuss the effects of this year's cold wave in greater detail in collaboration with Mr. K. V. Joshi and others.

A few photographs taken this year during the cold wave may be of interest. Figs. 5 (a) and (b) show an undamaged and a damaged guava plant; Figs. 5 (c) and (d) show an

undamaged and a damaged bush of vine. Figs. 6 (a) and (b) show the meteorological instruments kept inside the vine-garden of Mr. Phadatre (Nasik), and a wind break of dry jowar which proved ineffective respectively.

The camp observatory (see Fig. 6a) consisted of one set of instruments inside a garden and a similar set exposed in an open space near by.

The observatory was set up at Nasik early in January by the Agricultural Meteorology Branch with the co-operation of Mr. K. V. Joshi, Deputy Director of Agriculture.



**Fig. 5(a).**  
Healthy guava plant.



**Fig. 5(b).**  
Guava plant affected by frost.



**Fig. 5(c).**  
A healthy vine.



**Fig. 5(d).**  
Vine affected by frost.



**Fig. 6(a).**  
Camp Observatory inside vine-garden.



**Fig. 6(b).**  
Jowar wind-breaks.

Figs. 7 (a) and (b) show the hourly march of the percentage humidity and the air temperature respectively from 0800 hours of the 15th to 0800 hours of the 16th January when the cold wave was most intense. The records were obtained from hygro-graphs and

thermo-graphs kept inside two Stevenson screens which were placed on the ground. The dotted curves refer to conditions inside the vine-garden while the full lines refer to conditions outside in the open. It will be noticed that the air inside the garden was



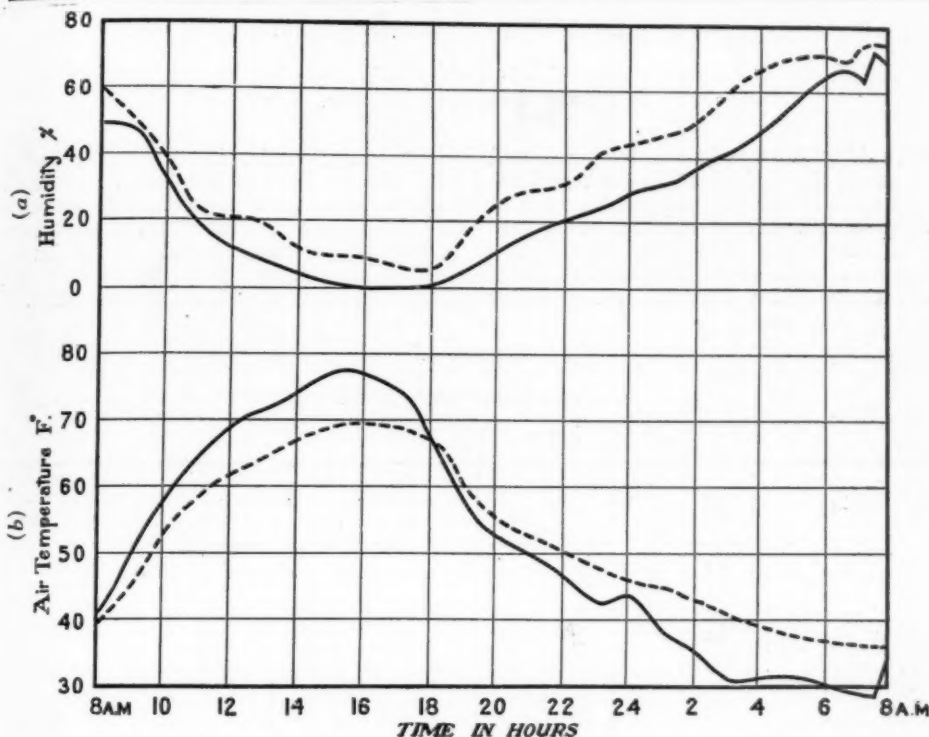


Fig. 7.

Hourly variations of humidity and temperature from 8 A.M. of 15-1-1935 to 8 A.M. of 16-1-1935 at Nasik  
Full lines refer to conditions inside a screen kept at ground level in the open. Dotted lines refer to conditions inside a grape garden in a similar screen at ground level.

more humid than outside at all hours and that the temperature was lower inside the garden than in the open during the day hours but higher during the night. The air temperature near the soil in the open was below 32° F. for nearly five hours on the 16th morning (0245 to 0745). Another noticeable feature is the extreme dryness of the air, *e.g.*, the percentage humidity was practically zero on the afternoon of the 15th. The data collected at Nasik will be discussed in greater detail elsewhere.

It is hoped that in the years to come the joint efforts of the Agricultural and the Meteorological Departments will help to solve the problem of frost prevention. The prevention of frost damage inside gardens will be more practicable economically than in the more extensive field crops; a beginning may be made at Nasik where the grape interests are concentrated over a small area. Adequate funds for detailed experiments on the efficacy of fires, wind-breaks, topography, etc., will be required for undertaking such joint investigations.

## The Cold Wave of January 1935.

By Dr. S. C. Roy,  
Colaba Observatory, Bombay.

THE cold spell experienced in north and central India during the first and the second week of January this year appears to have broken all past records when both intensity and duration are taken into account. The cold wave of Jan.—Feb. 1929 which created new records of low temperatures at many

Indian observatories is comparable to the 1935 spell in intensity but lasted for a much shorter period. A comparative statement of the lowest temperatures recorded at representative stations in the plains of north-west and central India in 1929 and 1935 is given in the following two tables.

TABLE I.

COLD SPELL OF JAN., 1935.

Air-Minimum 4 ft. above Ground (°F.)

Station	Jan. 12	Jan. 13	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Jan. 19	Jan. 20	Number of days with air-minimum below 32° F.
Peshawar (N.W.F.)..	34	29	32	38	32	31	32	33	40	5
Khanpur (W. Punjab)	31	31	29	29	33	31	29	32	35	7
Lahore (E. Punjab)..	34	31	31	29	32	28	28	28	33	7
Agra (U.P.) ..	47	44	37	34	28	33	31	30	33	3
Hyderabad (Sind) ..	45	42	34	36	38	39	41	42	45	..
Deesa (Gujarat) ..	55	39	33	28	30	35	40	38	46	2
Jodhpur (W. Rajputana) ..	44	37	36	30	33	41	40	41	45	1
Ajmer (E. Rajputana)	52	30	34	27	27	31	35	35	34	3
Indore (W.C.I.) ..	54	43	37	31	30	34	36	41	44	2
Nowgong (E.C.I.) ..	49	49	43	35	32	32	31	29	31	5
Malegaon (N. Bombay, Deccan) ..	55	46	37	33	33	36	37	48	51	..
Poona (S. Bombay, Deccan) ..	54	50	44	41	37	35	38	49	52	..

TABLE II.

COLD SPELL OF JAN.-FEB., 1929.

Air-Minimum 4 ft. above Ground (°F.)

Station	Jan. 29	Jan. 30	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Number of days with air-minimum below 30° F.
Peshawar (N.W.F.) ..	36	33	34	31	33	37	1
Khanpur (W. Punjab) ..	31	27	26	24	27	36	5
Lahore (E. Punjab) ..	39	38	29	32	31	34	3
Agra (U.P.) ..	44	47	33	29	30	39	2
Hyderabad (Sind) ..	42	36	30	36	40	47	1
Deesa (Gujarat) ..	42	39	34	31	36	51	1
Jodhpur (W. Rajputana) ..	46	35	30	33	38	40	1
Ajmer (E. Rajputana) ..	38	38	27	31	33	40	2
Indore (W.C.I.) ..	45	49	34	27	36	43	1
Nowgong (E.C.I.) ..	50	49	46	32	32	37	2
Malegaon (N. Bombay, Deccan) ..	47	54	34	31	34	47	1
Poona (S. Bombay, Deccan) ..	50	49	45	40	42	50	..

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These tables indicate briefly the intensity, duration and the progress of the two cold waves. It is seen from the above tables that the 1935 cold spell has been worse than the 1929 spell both in intensity and duration throughout north-west and central India outside the south-west Punjab and the adjoining parts of Sind.

The figures given in the tables represent the temperature of air at a height of about 4 ft. above the ground but temperature near the ground must have been several degrees lower. The grass-minimum temperature would have given a better estimate of the severity of the cold waves but such data are not available for all representative stations in India. Below is given a comparative statement of the air-minimum and grass-minimum temperatures as registered at Colaba during the last cold spell.

TABLE III.

Date	Air Minimum Temperature	Grass-Minimum Temperature
1935		
Jan. 14	60°.4	46°.5
" 15	53°.1	39°.2
" 16	54°.5	40°.1
" 17	53°.8	40°.1
" 18	57°.8	45°.1

It will be seen from the above data that the grass-minimum temperature was about 13 to 14 degrees below the air-minimum temperature at Colaba during the cold wave. Neglecting uncertainties of a few degrees the same must have been true at all other representative stations given in Table I.

Three or four degrees of frost in terms of the air-minimum temperature may, therefore, really mean 15 to 20 degrees of frost near the ground. Such a degree of frost cannot but be damaging to tender plants, crops and vegetables. It is, therefore, not surprising that reports of damage to crops are already appearing in the Press but we may have to await further reports to form a comprehensive estimate of the damage done by the last cold wave.

The results of a few soundings taken over Agra during the passage of the 1929 cold wave enabled Mr. G. Chatterjee and the present writer<sup>1</sup> to make an inference in regard to the origin of that cold wave. During winter the normal height of the tropopause over Agra (Lat. 27° N.) is about 14.5 gkm. and its temperature is 260° absolute<sup>2</sup> while with the invasion of the 1929 cold wave, the base of the Agra stratosphere came down so low as 11.5 gkm. and its temperature rose to 213° absolute. The conditions in the troposphere and the stratosphere over Agra during the 1929 cold spell were similar to those normally found at about Lat. 40° N. The trajectories of the pilot balloon flights indicated that the cold air came from the north-west. It was, therefore, inferred that the cold wave of 1929 had its origin somewhere to the east of the Caspian Sea. Sounding balloon data during the last cold wave are not available yet. It would be interesting if soundings over Agra during the last cold spell confirm the 1929 observations.

<sup>1</sup> *Nature*, 1929, 124, 579.

<sup>2</sup> Ramanathan, *Nature*, 1929, 123, 834. (See Fig. 1.)

## Modification of Swim-Bladder in Certain Air-Breathing Fishes of India.\*

By Sunder Lal Hora, D.Sc., F.R.S.E., F.A.S.B.,

Zoological Survey of India, Calcutta.

IN a general sense, the swim-bladder of fishes performs a hydrostatic function, but there are many structural anomalies which have neither been explained nor correlated with any variations in the habits of their possessors. In 1830, Taylor† directed attention to the modifications of the bladder in certain air-breathing fishes of India, but, so far as I am aware, these modifications have not been correlated with the habits of the fishes. For carrying out certain physiological experiments, several kinds of air-breathing fishes were kept in aquaria and it was observed that different species behaved differently when at rest. For instance, *Heteropneustes* (= *Saccobranchus*) floated in any position with its dorsal surface directed upwards; *Clarias* and *Amphipnous* floated vertically so long as their air-chambers were full of air; while *Ophicephalus* and *Anabas* did not float at all even after taking a fresh supply of air in their respiratory chambers; they lay quietly at the bottom for most of the time. For an explanation of their behaviour, I studied the form of their swim-bladder with the following results.

With the development of additional receptacles for the storage of air for respiration, it is evident that some adjustment of the hydrostatic organs had to take place. In *Clarias* and *Amphipnous*, the air-chambers are at the anterior end, and as the habit of these fishes is to lie suspended vertically for most of the time, they can keep the anterior end buoyant with the help of the air-chambers. A bladder in the abdominal cavity would have been a disturbing factor under the circumstances and is, therefore, either greatly reduced or lost altogether. *Ophicephalus* and *Anabas*, in spite of the extensive air-cavities in the head, are enabled to lie at the bottom by the extension of the swim-bladder in their caudal region. Thus the development of the buoyant chambers at the anterior end is balanced by the portion of the air-bladder enclosed in the caudal region. The long, dorsal tubes of *Heteropneustes* replace the

ventral swim-bladder which becomes greatly reduced and enclosed in bone. The fish is enabled by the tubes to float or lie at the bottom, as the buoyant area is thus uniformly distributed all over the surface of the fish.

The study of the estuarine Gobioid fishes,‡ all of which are capable of aerial respiration under adverse circumstances, also leads to the conclusion that definite correlation exists between the form and position of the bladder and the mode of life of the different species. *Glossogobius giurus*, *Eleotris fusca*, *Bulis bulis* and *Stigmatogobius sadanundio* swim about freely and, though capable of living out of water for some time, are in the main water-breathing fishes and do not show any marked development of the gill-chambers. Consequently, the swim-bladder is extensive and of the normal type. *Pseudapocryptes lanceolatus*, *Apocryptes bato* and *Tænioides rubicundus* live in deep burrows, usually under water, and have developed large gill-chambers for aerial respiration under adverse circumstances. These eel-like fishes do not swim about and when the water is foul, they hang from the surface by distending their air-cavities (gill-chambers) with air. Under the circumstances, the bladder is of little use and, in consequence, it is greatly reduced. *Periophthalmodon*, *Periophthalmus* and *Boleophthalmus* are almost terrestrial in their habits and possess well-developed cheek-pouches for the storage of air. The air-bladder is absent in these genera.

From the above it is clear that the size and position of the swim-bladder in fishes are definitely correlated with their mode of life, and the structural modifications, referred to above, especially in the case of the freshwater air-breathing fishes, are, no doubt, induced by the presence of air-chambers. These observations lend considerable weight to the view that the present chief function of the swim-bladder is to act as a hydrostatic organ, for where other structures have appeared to interfere with this

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† Taylor, J., "On the Respiratory Organs and Air-Bladder of Certain Fishes of the Ganges," *Gleanings in Science*, 1830, 2, 169-176.

‡ Mr. Dev Mukerji of the Zoological Survey of India is at present engaged in investigating the correlation between the structure of the air-bladder and the ecological factors in the case of Gobioid fishes in the Gangetic delta.

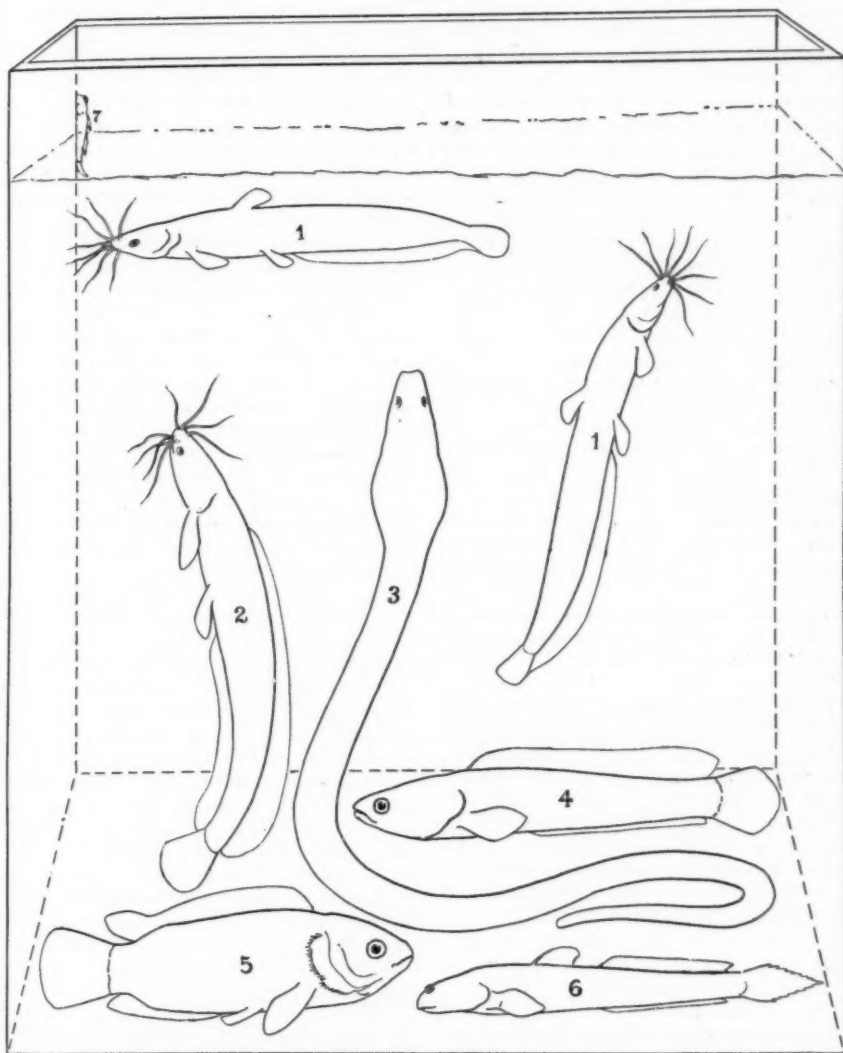
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Position at Rest of Certain Air-Breathing Fishes of India.  
(Diagrammatic.)

1. *Heteropneustes fossilis*.
2. *Clarias batrachus*.
3. *Amphipnous euchia*.
4. *Ophicephalus punctatus*.
5. *Anabas testudineus*.
6. *Pseudapocryptes lanceolatus*.
7. *Periophthalmodon schlosseri*.



function, the bladder has either disappeared functionally or has become greatly modified to meet the new requirements. The probable mode of origin of the type of air-bladder found in *Anabas* and *Ophicephalus* is discussed below.

The extension of the air-bladder in the caudal region among the Anabantidae and the Ophicephalidae is a remarkable morphological feature of these fishes. It has been indicated above that they are provided with extensive chambers in the head region for storing air for respiration and, in spite of these buoyant structures at the anterior end, they spend most of their time lying horizontally at the bottom. To reconcile these two facts, one has to imagine a type of fish before the development of the air-

chambers. In an ordinary fish, the air-bladder is situated in the abdominal cavity and the fish is enabled to move up and down or lie at the bottom without feeling inconvenienced. The ancestors of the Anabantidae and the Ophicephalidae were probably bottom fishes. When they developed the habit of breathing air and storing it in cavities in the head, the anterior end became buoyant, so, for bottom life, they had to spend a great deal of energy to keep the front end down. Thus, such a fish had to swim almost constantly with the head directed downwards and the body inclined at an angle. Under these circumstances, the air in the air-bladder began to exert some pressure on the neighbouring ventral muscles of the caudal region which gave way and enabled the extension of the bladder backwards. This process must have continued for some time, till the buoyant tendencies of the anterior part of the fish were balanced by the extension of the bladder right up to the base of the caudal fin and it could lie at the bottom without any exertion.

§ *Clarias* and *Heteropneustes* (= *Saccobranchus*) are generally regarded as mud-inhabiting fishes of India. Though capable of living in mud when the water dries up, they are by no means mud-fishes, for they keep floating in water, usually near the bottom. It was under a misapprehension, therefore, that I (*Proc. 17th Ind. Sci. Cong., 1930, 229-243*) attributed the reduction of the air-bladder in these fishes to a ground habit of life. The most plausible reason for the reduction of the bladder is to be found in the development of air-chambers and the floating habit of these fishes.

These observations show how identical modifications sometimes result from widely different causes, and, in consequence, the great need of field observations in the study of adaptations—correlation of form and habits. Cases are known of divergent modifications under similar environmental conditions (Horn, *Phil. Trans. Roy. Soc. London* (B), 1930 a, 218, 266), and in the case of the reduction of air-bladder in fishes similar modifications have resulted from different causes. The result in all cases is the adjustment of an organism to the external conditions of its existence.

The origin of the air tubes of *Heteropneustes* and of the air-bladder in fishes has to be traced to a similar habit. In the beginning, these structures probably developed as small pouches for storing air in the head region and when the anterior end became buoyant and the fish had to struggle for lying at the bottom, the backward extension of these pouches resulted in the setting up of the proper equilibrium. These observations lend support to the view that air-bladder probably developed as an organ of aerial respiration and that its present hydrostatic function is only a secondary acquisition.

### Institute of Oil Technology, Nagpur.

THE Committee appointed by the Nagpur University in April 1933 to investigate the economic potentialities of the development of Oil Technology in Central Provinces and Berar, have recently issued their Report. The Committee recommend the establishment of an Institute at a capital cost of 3.5 lakhs of Rupees and an annual recurring expenditure of 51,000 Rupees. The Institute will provide a three-year course leading to the B.Sc. Degree in Technology and a one-year course leading to the M.Sc. Degree. Provision is made for 36 under-graduate and 12 post-graduate students. The course

of study includes Chemical Technology and Engineering, Physics and Mathematics bearing on engineering problems, commercial economics, accountancy and industrial administration. Plants for the manufacture of soaps, candles, paints and varnishes will be erected so as to afford training of a semi-commercial character to students. If run on commercial basis, the plant is expected to pay its own way. It is hoped that with the help of the Lakshminarayan Bequest, the University will soon be able to establish the Institute.

# Some Recent Advances in Indian Geology.\*

By V. P. Sondhi,  
*Geological Survey of India.*

## 4. The Geology of Burma.

DURING the past fifteen years a considerable advance has been made in our knowledge of the geology of Burma, and although valuable contributions have been made by workers outside the Geological Survey of India, especially concerning the Tertiary oil belt, for the most part the progress has been mainly due to the official survey. In order, therefore, to follow the progress made in Burma during recent years, it is necessary to follow the activities of the official survey in the province.

Since 1920, about when systematic survey operations were resumed in Burma after a lapse of several years, large tracts of the country have been mapped on the standard topographical sheets of the scale of one inch to one mile. For several years in the beginning of the period practically the whole strength of the Burma party was devoted to the mapping of the Tertiary belt. But later on, while this work continued, activities became scattered over areas so wide apart as Mogok and Myitkyina in the north, Amherst and Mergui in the south, and the Shan Plateau on the east. These centres of investigation are geologically so distinct and independent of each other that our best course will be to follow the trend of investigation in each separately.

### THE TERTIARY BELT.

Since Sir Edwin Pascoe's classic memoir on the oilfields of Burma,<sup>1</sup> the most important contribution to our knowledge of the history of Tertiary deposition in Burma has been made by G. de P. Cotter with the help of his colleagues, through their field work in the foot-hills of the Arakan Yoma in Upper Burma, and through the valuable palaeontological researches of E. W. Vredenburg.<sup>2</sup> The record of the Tertiary sequence on the eastern flanks of the Arakan Yoma is preserved so fully that it really constitutes the key to the history of deposition in the Tertiary Era in the province. Cotter was able to prove through his work in the

western parts of the Minbu district that the Arakan Yoma existed as a narrow strip of land at the commencement of the Tertiary, and was able to demonstrate a lateral as well as vertical variation of rock facies according to which each stage is represented by a gradually shallower condition of deposition when followed northwards, the variation amounting to replacement of the marine by estuarine and fresh-water beds. Research along those lines led Cotter to the important conclusion that the Tertiary basin of deposition was in reality a typical geosynclinal area lying between the Shan Plateau and the narrow strip of land representing the Arakan Yoma, and that as the head of the gulf that occupied it gradually filled up in the north, where the major portion of the sediments came from, the sea retreated to the south. Thus the fluviatile sediments and deltaic deposits kept continually advancing southwards pushing the sea before them, and at the same time the area of subsidence also kept shifting to the south. Cotter published his views in 1918, and it is necessary to refer to them here since his conception of the history of Tertiary deposition has formed the basis of subsequent research in this line.

In a series of papers from 1922 onwards L. Dudley Stamp attempted to elaborate the original conception of Cotter with slight modifications and additions of detail.<sup>3</sup> In 1922 he emphasised the existence of intermittent folding movements at an early stage in the evolution of the geosyncline, which caused further elevation of the Arakan Yoma and further depression and buckling of the floor of the geosyncline, resulting in the temporary returns northward of marine conditions that have left wedges of marine sediments in between layers of continental type. Subsequently he postulated a marked variation between the time-planes and the lithological planes,<sup>4</sup> and advocated a grouping on the basis of cycles of marine invasion.<sup>5</sup> At the same time he suggested a modification of Vredenburg's sub-division of the Pegu Series. But these views have not found

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<sup>1</sup> *Mem. Geol. Surv. Ind.*, 1912, **40**, 1-269.

<sup>2</sup> *Journ. As. Soc. Beng.*, 1918, **14**, 409.

<sup>3</sup> *Geol. Mag.*, 1922, **59**, 481.

<sup>4</sup> *Op. cit.*, 1925, **62**, 515.

<sup>5</sup> *Trans. Min. Geol. Inst. Ind.*, 1923, **17**, 161.

support in more recent work, as we shall see presently. They are mentioned here only to show the different lines that have been explored in recent years to arrive at a satisfactory understanding of the Tertiary sequence in Burma.

At the World Petroleum Congress held in London in July 1933, G. W. Lepper of the Burma Oil Company Limited, briefly outlined the Tertiary geology of Burma, and contributed a large amount of hitherto unpublished information based on the results of many years' incessant work by the geological staff of the Company.<sup>6</sup> This contribution, therefore, is of unusual authority and interest, and carries us a long way in our knowledge of the sequence and structure of the Tertiary deposits of Burma and the connection of the latter with the occurrences of commercial petroleum. P. Evans summarised the paper recently,<sup>7</sup> but some points of unusual interest must be mentioned here even at the risk of repetition.

A very important point brought out by Lepper is the recognition of a long synclinal trough which forms a striking feature of the geological structure of the Chindwin-Irrawaddy Valley, and which separates the western monocline, composed of a complete succession of the Tertiary deposits flanking the Arakan Yoma, from a broad series of folds to the east. This structure is found to persist from latitude 24° (west of the Indaw anticline) in the north, across the Chindwin River near Mingin, to the west of the Mahudaung anticline. From there it runs through the Pakokku district and the oilfields, into the Thayetmyo district in the south, where it narrows and becomes split up by anticlinal folds running across its strike. It reaches its maximum development west of the Yenangyaung and Singu-Lanywa-Yenangyat oilfields, and separates these and the Minbu oilfield from the monoclinical succession in the west. This median syncline is of very great importance not from the structural point of view alone but because the occurrence of commercial petroleum is closely connected with it. It has been established that all the producing fields lie in the closed structures that border the synclinal immediately on the east, and with the exception of the Indaw oilfield, situated near its north end, the main group of

oilfields lies near its maximum development opposite Yenangyaung. According to Lepper circumstances similar to those attending the origin and migration of oil in some of the American fields, as explained by V. Illing,<sup>8</sup> may have prevailed in Burma from Middle Eocene to Middle Miocene. Conditions favourable for the accumulation of organic matter suitable for the formation of petroleum persisted more continuously in the shallow marine tract occupied by the synclinal, where thinner sediments were deposited, than on its east and west. And with the compaction of the strata oil and salt water were expressed and moved laterally to the coarser deposits of the margins. Uplift of the latter initiated the segregation of gas, oil and salt water during the post-Pliocene folding. Thus we find oil in quantity confined to the belt of folds that lie immediately to the east of the syncline. Beyond this belt the oil seepages are rare and test wells have struck little or no oil. The oil which migrated towards the western margin of the syncline had no opportunity to accumulate as no closed structures exist on that side.

Another equally interesting contribution made by Lepper gives the result of a close examination of the whole Tertiary sequence forming the long easterly-dipping monocline along the eastern flank of the Arakan Yoma. Members of the Pegu Series (Oligo-Miocene) were found to become more arenaceous when followed northwards, as demonstrated by Cotter, but in addition well-defined palaeontological breaks are recognised at the top of the Yaw Stage (Eocene), and between the Oligocene and Miocene, the latter break dividing the Pegu into two parts of equal thickness. Another widespread unconformity is recorded between the Irrawaddy series (Mio-Pliocene) and the Pegu series, and a new classification has been suggested.<sup>9</sup>

An important result of these researches is that the divergence of time-planes and lithological planes advocated by Stamp all these years does not find support in the evidence brought forward by Lepper. With the present facilities of coring the underground strata of the central oilfields by rotary drilling it has become increasingly possible to correlate the stratigraphical sequence of this area with that of the outcrops west of the syncline, in spite of the difficulties raised

<sup>6</sup> World Petroleum Congress, London, 1933, reprint 169.

<sup>7</sup> *Trans. Min. Geol. Inst. Ind.*, 1934, 29, 67.

<sup>8</sup> *Journ. Inst. Petr. Tech.*, 1933, 19, 229.

<sup>9</sup> See Reference 6.

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As regards the progress which has been made during recent years in the oilfields development, the reader is referred to the proceedings of the World Petroleum Congress of 1933, and to the annual reports of the Director, Geological Survey of India, since 1927, when the practice of having a Resident Geologist permanently at Yenangyaung was revived.

#### THE TERTIARY IGNEOUS ROCKS OF BURMA.

Tertiary igneous activity in Burma began in Eocene times, and with intermittent quiescent periods of varying duration revived in early Irrawaddy (Mio-Pliocene) and again in Pleistocene and sub-recent times. The different periods of activity are remarkable more for the extent in space over which the phenomena are exhibited than for the amount of material poured out, and all the successive activities appear to have followed more or less the same tectonic lines from beginning to end. The present-day surface indications suggest that the later activities were the more energetic and, although still following the older zones, their manifestations extended far beyond the earlier limits.

The most important centres of activity are seen to follow an important tectonic line that traverses the entire length of Burma and runs approximately through the centre of the Irrawaddy-Chindwin basin. Beginning with the Myitkyina occurrences in the north it runs through the Mingin Range volcanics west of Wuntho, to the explosion craters of the Lower Chindwin district, and from there it continues south through the Shinmadaung hill range in Pakokku district, and through Mount Popa to the dolerite dykes and sills of the Pegu Yoma. When continued further south this line passes through the volcanic islands of Narcondam and Barren to the volcanic regions of Sumatra. In the Lower Chindwin district a subsidiary line runs parallel to it, in the hill ranges east of Monywa.

Another line, though of less importance, runs along the western edge of the Shan Plateau. Along this line are found the intrusive and extrusive rocks of the Male-Kabwet area in the Shwebo district in the north, the rhyolites and tuffs in Thaton, the volcanics of Maingy and Elphinstone Islands off the coast of Tavoy, and the basalts of Medaw Island south of Murgyi. Only a very short account of the various centres of activity in which research has been

carried out in the period of the present review can be attempted here, beginning in the north.

H. L. Chhibber, during his recent work in the Jada Mines area in the Myitkyina district, which is the point furthest north at which Tertiary igneous rocks have so far been mapped, found the extinct volcano of Mount Loimye, which rises 5,124 feet above the sea-level, and is thus higher than Mount Popa which it somewhat resembles in its structure and ejectamenta.<sup>10</sup>

Although the volcanic rocks of the Mingin Range form the biggest centre of vulcanicity in Burma, practically nothing has been added to Noetling's description of long ago.<sup>11</sup>

In Lower Chindwin district there is a belt of volcanic occurrences 25 miles wide, following roughly a N.-S. direction. It includes the string of eleven extinct explosion-craters situated in a straight line, some 13 miles long, running across the Chindwin river at Shwezaye in a N.E.-S.W. direction. From the spectacular point of view they form the most interesting occurrence, being represented by great hollow pits the bottoms of most of which are now covered by lakes. R. D. Oldham<sup>12</sup> was the first to describe these explosion-craters, and so far as the description of surface features goes his observations can hardly be improved upon, though the rocks themselves have since been studied in greater detail. In 1925 P. Kelterborn published a short note on some specimens collected from this area.<sup>13</sup> In 1927 Messrs. Pinfold, Day, Stamp and Chhibber described the igneous rocks of the whole district,<sup>14</sup> while during 1926-28 the writer mapped these occurrences in the course of the systematic mapping of these districts. The most important account, however, is the one given by C. Burri and H. Huber in 1932.<sup>15</sup> According to these workers the rock types include liparites, andesites, basalts, ultra-basic rocks, and tuffs and similar rocks. The olivine-basalts are the most widespread, and some of them have proved to be alkali basalts under-saturated with silica and containing normative nepheline. The ultra-

<sup>10</sup> *Rec. Geol. Surv. Ind.*, 1930, **63**, 101.

<sup>11</sup> *Op. cit.*, 1893, **26**, 26.

<sup>12</sup> *Op. cit.*, 1906, 137.

<sup>13</sup> *Eclog. Geol. Helv.*, 1925, **19**, 352.

<sup>14</sup> *Trans. Min. Geol. Inst. Ind.*, 1927, **21**, 145.

<sup>15</sup> *Schweiz. Min. Petr. Mitt.*, 1932, **12**, 286.



basic rocks ejected by the Twindaung crater are represented by pyroxene-hornblende which is found to contain by mode 85 per cent. hornblende and 15 per cent. pyroxene, approaching nepheline-basanite in chemical composition, and by biotite-pyroxenite which is found to contain 40 per cent. biotite and 60 per cent. augite, approaching leucite-basanite to olivine-leucite in chemical composition.

In the hills west of Monywa devitrified rhyolites, quartz-porphry and muscovite-porphry have been recorded. The detailed survey of the part of the Lower Chindwin east of Monywa by the present writer in 1927-28 brought to light a few additional volcanic occurrences. Most of them are situated along a fault line that runs in an approximate N.-S. direction.

The next volcanic occurrences to the south are found in the Salingyi upland (sheet 84 0/1) mapped by Barber in 1925-26. The rocks here comprise dacites, dolerites and coarse diorite forming a suite of pronounced calc-alkali type. Further south the line passes through a small outcrop of lava exposed in the Shinmadaung hill range, along the western flanks of which hornblende-andesites, basalts, tuffs and rhyolitic agglomerates and breccia occur.

Although dolerite dykes and sills are known to occur in the Pegu Yoma further south, Mount Popa in the Mingyan district forms the most conspicuous southerly manifestation of late Tertiary volcanic activity in the Irrawaddy basin. A preliminary account of the lava flows of this area was given by Sir Edwin Pascoe in 1909, and more recently the rocks have been described by Chhibber.<sup>16</sup> Barber worked on the eastern slopes of the mountain in 1926 and the representative collections made from this area and from the Shinmadaung range and Salingyi area are at present being studied by him. Volcanic activity in this region probably commenced at an earlier time than elsewhere, although the period of maximum activity may be Irrawaddian.

Mount Popa itself is built of lava flows, tuffs and agglomerates of Pleistocene to sub-Recent age. Older volcanic rocks also occur and include a repetition of different types of andesites and rhyolitic rocks, both associated with tuffs. The different rock types in the younger lavas are all easily matched

with one or the other of the types occurring in the Lower Chindwin, so that it is quite clear that igneous rocks in these two distant centres belong to the same petrographic province.

The most important centre of igneous activity on the second line—that following the western edge of the Shan Plateau, is the most northerly known occurrence, that of Male-Kabwat region. Stamp and Chhibber published an account of this area in 1927.<sup>17</sup> The present writer mapped the area in the course of his routine survey of the Shwebo district during the season of 1928-30, and whilst his mapping is mainly in agreement with that of Stamp and Chhibber, he made one noticeable addition by discovering that the anticlinal axis through Nattaung Hill and Letkokpin is followed by a parallel synclinal axis to the east running through Kabwet, and that the spheroidal lava regarded by Stamp and Chhibber as a dyke intrusion was in fact a sheet of lava, taking part in the fold and appearing on either limb of the syncline.

Records of more than one period of igneous activity are preserved here. The older lava is interbedded with the Irrawaddy beds and shows beautiful examples of pillow structure. Intrusions are represented by a sill and dykes, and the younger olivine basalts, extruded in Pleistocene or sub-Recent times, build the hill Lethataung, 1,674 feet above sea-level, opposite Kabwet. The peak is regarded by Stamp and Chhibber as marking the focus of eruption; but the writer is of opinion that those lavas came from fissures, one of which passed through the position that now forms the crest of the hill range of which Lethataung is the culminating point. The lavas of Singu to the south are part of the same extrusion. North of Kabwet the volcanic activity is represented by decomposed amygdaloidal lava interbedded with the Irrawaddy beds, and by the long lines of dolerite dykes between Kabwet and Male. This line of activity corresponds with a zone of tight folding and crushing of the late Tertiary beds against the crystalline rocks of the Mogok series, and the junction between the two is most probably a faulted one. A very interesting character of the rocks of this region is that they show an 'Atlantic' or alkaline tendency of differentiation, whereas the rocks of all the igneous centres on the main line

<sup>16</sup> *Trans. Min. Geol. Inst. Ind.*, 1927, 21, 129.

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The next known area of vulcanicity along this line lies near Mokpalin, in the Thaton district, where rhyolites and rhyolitic tuffs are seen to overlie a sedimentary series of probably Carboniferous age.<sup>18</sup> They strongly resemble the occurrences west of Monywa in Lower Chindwin district, and are regarded as of the same age. Continuing along this line to the south we come to the coarse volcanic agglomerates of Maingy Island and a series of rhyolites and porphyries on the western coast of Elphinstone Island, off the Tavoy Coast. The age of these rocks is uncertain. The southernmost volcanic occurrence is that of the island of Medaw in Mergui, where basalt fills up most of the low-lying ground. The area was visited by M. Vinayak Rao in 1922,<sup>19</sup> and a description of the rocks is included in Sethu Rama Rau's memoir on the Geology of Mergui.<sup>20</sup>

#### THE MOGOK GEM STONE TRACT.

The large-scale geological mapping of the Mogok stone tract that has been in progress for the last few years and is now nearing completion has considerably increased our knowledge of the geology of this interesting area. The Archæan rocks which occur here have now been divided into a number of stages and mapped separately. This work was begun by J. Coggin Brown and A. K. Banerjee in 1929, and has since been continued by E. L. G. Clegg and L. A. N. Iyer.<sup>21</sup>

The rocks found here include metamorphosed sediments, now appearing as crystalline schists, and a varied suite of intrusive igneous rocks. The metamorphic rocks include quartzites, limestones, calciphyres, and a number of unclassified gneisses. The quartzites, which may be either of replacement or of sedimentary origin, occur in association with calc-gneisses, in some cases passing imperceptibly into calc-granulites. The limestones, calciphyres and calc-gneisses are usually found in association and grade into one another. Although at first sight they appear to occur in discontinuous bands following the general E. 30° N. strike, the mapping indicates that they are probably the remnants of continuous strata reduced

to the present isolated fragments by the combined effects of intrusions of syenites and granites, which have eaten their way into them to a large extent, and of the folding and denudation that did the rest. These rocks are of wide-spread occurrence in the tract and show a variety of types containing a number of accessory minerals. Prof. Alam's statement that the limestones and gneisses exposed continuously from Thabeitkyin to Mogok strike north and south is not borne out in general in the area.<sup>22</sup>

The unclassified crystalline rocks, comprising a variety of gneisses and intrusive rocks, appear to be the metamorphosed derivations of argillaceous and arenaceous sediments, intruded along their planes of schistosity by a series of granites, syenites and pegmatites.

The igneous rocks occur in great variety, and the following are the chief types found. The basic and ultrabasic rocks are represented by medium to coarse-grained holocrystalline peridotites. The hornblende-ægirine-nepheline rocks and hornblende-ægirine-scapolite rocks occur in small intrusions or bands usually associated with limestones or, in certain instances, as marginal fringes of syenite intrusions. The syenites were first recognised in the field by Dr. L. L. Fermor and are of a wide distribution, ranging from quartz-syenite to dioritic monzonite. The felspar of the latter are predominantly andesine, and the pyroxene is either augite, ægirine-augite or ægirine. Certain types containing hypersthene approach the intermediate members of the charnockite family of Southern India. The augite and hornblende-granites of the area appear to be a more acid phase of the syenitic magma.

Apart from the description of the various rock formations and their large-scale mapping, which have a value and interest of their own, the recognition of certain points of resemblance between the Burmese Archæan rocks and those of similar composition in Peninsular India constitutes a considerable advance in our knowledge, and we owe it largely to Dr. Fermor's short visit to the Mogok area and his subsequent study of rock specimens collected therefrom. Some of the garnet-sillimanite-gneisses occurring in patches in the Bernardmyo tract have been found by Dr. Fermor to be identical with the khondalite of Peninsular India. Rocks of the Mogok stone tract, according to him,

<sup>18</sup> *Proc. 14th Ind. Sci. Congr.*, 1927, 239.

<sup>19</sup> *Rec. Geol. Surv. Ind.*, 1924, 55, 32.

<sup>20</sup> *Mem. Geol. Surv. Ind.*, 1933, 55.

<sup>21</sup> *Rec. Geol. Surv. Ind.*, 1931, 65, 80-86; *op. cit.*, 1932, 66, 92-96; *op. cit.*, 1934, 68, 59-57.

<sup>22</sup> *Op. cit.*, 1931, 65, 80.

exhibit a grade of metamorphism characteristic of the hypomorphic zone (Grubenmann's 'katamorphic zone') and have their analogues in the rocks of the Eastern Ghats of India and Ceylon. The garnetiferous granulites are especially interesting in this respect because they approach in mineral composition the felspathic khondalites of Ceylon. Certain hypersthene-biotite-granulites show a charnockite type of metamorphism, and the cordierite-rocks from the Yebu Chaung recall some of the hybrid rocks described by T. L. Walker and W. H. Collins from the Vizagapatam district of South India.

#### THE JADE MINES AREA.

Since A. W. G. Bleek's description of the geology of the Kachin hills in connection with the jadeite, published in 1908,<sup>23</sup> there has been practically no serious geological work done in this region, with the exception of Murray Stuart's traverses across portions of it in the field season 1920-21,<sup>24</sup> until Chhibber commenced the survey of the Jade mines area in 1928.<sup>25</sup> These investigations are still in progress. Systematic mapping has so far been confined to the Jade mines area, in the Kamaing sub-division, but the geology of large tracts of the neighbouring areas is known through traverses to the Chinese frontier and to the Hukawng valley.

The most interesting feature of this region lies in the preservation of the record of several periods of igneous activity dating from post-Permo-Carboniferous up to sub-Recent times. The chief sedimentary formations are the Permo-Carboniferous limestones and the Tertiary rocks. The former overlie unconformably towards the north-east rocks resembling Chaung Magyis (Pre-Cambrian) in lithology, while into the Tertiary rocks are intruded a variety of igneous rocks. There are also crystalline schists which are regarded by Chhibber as ortho-schists. The Permo-Carboniferous are intruded by a batholith of a medium grained granite, represented by a variety of types among which biotite and muscovite-granites predominate. The intrusion is regarded as of Triassic age in common with certain other intrusions in Burma. There are also peridotites and serpentines of probable Upper

Cretaceous or Lower Eocene age. Into these latter are intruded the albite-jadeite rocks which are the parent rock of the well-known jade.

The sedimentary Tertiary rocks of the area are now sub-divided as follows:—

Uri boulder conglomerates.

Namting series.

Hkuma series.

The Hkuma series is a thick deposit of a well-bedded sandstone in which occasional intercalations of shaly layers occur. An interesting feature of this series is that the heavy mineral assemblages of these rocks correspond to those of the Barail series (Eocene-Oligocene) of Assam, which corresponds to the Upper Eocene and lower half of the Pegus in Central Burma. Similarly, the Namting series, composed of a considerable thickness of sandstones, shales and conglomerates, has yielded heavy minerals that agree closely with the Tipam series of Assam, corresponding to a portion of the Upper Pegus.

Another interesting feature of this area is the manifestation of igneous activity in post-Tertiary times. This has already been referred to above.

#### THE MERGUI ARCHIPELAGO.

During the period under review the geological survey of the accessible parts of the Mergui district was completed, and an account by Sethu Rama Rau was published in 1930.<sup>26</sup> The geology of the northern portion of the archipelago was described by Coggin Brown and A. M. Heron in 1923.<sup>27</sup>

An area in this region that has attracted geological attention in recent years is the Amherst district, where a considerable amount of work has been done. It is impossible, however, to summarise it all within the limits of this article, and a few only of the more important conclusions will be referred to here. Towards the end of 1921 J. W. Gregory<sup>28</sup> and G. de P. Cotter<sup>29</sup> examined the eastern parts of the district in connection with the investigation of the oil shales that occur there, and important knowledge of this hitherto unexplored but geologically very interesting part of Burma was obtained. The oil shales are of late

<sup>23</sup> *Op. cit.*, 1908, 36, 257.

<sup>24</sup> *Op. cit.*, 1923, 54, 398.

<sup>25</sup> *Op. cit.*, 1929, 62, 108-114; *op. cit.*, 1930, 63, 97-102; *op. cit.*, 1932, 66, 50-57.

<sup>26</sup> *Mem. Geol. Surv. Ind.*, 1933, 55.

<sup>27</sup> *Op. cit.*, 1923, 44.

<sup>28</sup> *Geol. Mag.*, 1923, 60, 152.

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Tertiary age, and were deposited in basins comparable with those found in the Shan Plateau, Tavoy and Mergui, and indeed far beyond the limits of British India, in Yunnan, Indo-China and Siam. The main Tertiary basin of Pliocene age in which oil shale occurs is the structural valley enclosed by the Dawna range and the Choehko Taung. The Dawna range is built mainly of banded gneisses, schists and gneissose granite, and Cotter's discussion of the age of the gneissose granite constitutes a valuable contribution to our knowledge of the granites of Burma as a whole. In this paper he has gathered together evidence from within Burma and from the neighbouring country of Siam pointing to a Triassic age for some of the Burmese granitic intrusions. Coggin Brown has since brought forward evidence to prove a similar age for the Thaton granite which, he believes, is identical in composition, age and mineral association with the major granite intrusions that stretch from Mergui into the foothills of the Shan Plateau, east of the Kyaukse and Yamethin districts.<sup>30</sup> Most probably these are all of the same age and comparable with the granites of British Malaya, Sumatra, Borneo and the Dutch East Indies.

Another point of much geological interest connected with Cotter's work in this area is his discovery of fossils in the limestones exposed in the Thoungyin river. Although the fossils were found to be in a most disappointing state of preservation, G. H. Tipper, who examined them tentatively, came to the conclusion that they indicated a Triassic age. The attribution of this age to the limestone came rather as a surprise at the time and was accepted only doubtfully, because no limestone of that age had been recorded from the extensive developments of the formation in the surrounding regions of the Shan Plateau, Mergui and Moulmein. Tipper's view, however, was later proved to be perfectly correct by specialists such as Gregory, Julius Pia, Trouth and Weir<sup>31</sup>, who worked out the collections a few years ago. It appears possible, therefore, that these limestones represent an upward extension of the Plateau Limestone into the Trias, though hitherto it was considered to have ended with the Permian.

#### THE SHAN PLATEAU.

Work by the Geological Survey of India

on the Shan Plateau was resumed simultaneously in the Northern and Southern Shan States in 1928. In the Northern States the work has mainly been confined to the extension northwards of T. de la Touche's map of this area published in 1912.<sup>32</sup> In the course of this work several new fossil localities have been discovered, of which the most important is M. R. Sahni's discovery of a unique assemblage of ammonites, gastropods and lamellibranchs in the Plateau limestone at Nam Hkyam.<sup>33</sup> The ammonites include *Xenorhis carbonaria* Waagen, recorded from the Permian of the Salt Range and from Chitral. Another genus is *Nannites*, of which two species have been found, one of which shows affinities with a species recorded from the Otoceras beds of Spiti. The new genus *Hungoritide* is the most common ammonite represented. Among the gastropods *Pleurotomaria* and *Naticopsis* are the most dominant. Of the lamellibranchs *Schizodus* is very common.

As regards the Southern Shan States, our knowledge of the geology of this area was very meagre prior to the period under review. As a result of recent work by Coggin Brown and the writer some 2,900 square miles have already been mapped on the scale of one inch to one mile, and in addition extensive traverses have been made running up to the eastern frontier of the Indian Empire. Generally, the geology of this region is essentially the same as that of the Northern Shan States and the only differences are those of minor details. The chief interest of the region is centred on the Ordovician-Silurian succession of which a number of rock facies and horizons are present. Several new fossil localities have been discovered, but, although of very great interest to the science, most of the assemblages have been rather disappointing as regards their correlative value, for in almost all the collections so far examined the majority of forms that are specifically identifiable have turned out to be new to science, except in the case of the graptolite and tentaculite horizons at the bottom and top of the Silurian respectively.

A description of the geology of the country was published recently, and it need not be discussed in detail here.<sup>34</sup> Broadly speaking,

<sup>32</sup> *Mem. Geol. Surv. Ind.*, 1913, 39.

<sup>33</sup> *Rec. Geol. Surv. Ind.*, 1932, 65, 97.

<sup>34</sup> *Op. cit.*, 1933, 67, 135.

<sup>30</sup> *Op. cit.*, 1928, 60, 79.

<sup>31</sup> *Op. cit.*, 1930, 63, 155.

the numerous isolated outcrops of Ordovician rocks have been grouped into three divisions based on their fossil contents and lithology. The further sub-division of these groups has been rendered difficult owing to the lateral variations in the lithology and to the sharp differences in the fossil assemblages of different localities. From a number of large collections made by the writer from the Ordovician, F. R. Cowper Reed has been able to find only 33 forms which are in a sufficiently well-preserved state for specific description.<sup>35</sup> Of these 23 are new species. In the Silurian, excepting the graptolite and the tentaculite zones, there are only 4 specifically identifiable forms, and all of them are new. The Ordovician is much better developed here than in the Northern States, the Lower Ordovician, which is not found in the north, having been found in the south with forms allied to those occurring in Annam.

In the Plateau Limestone group the true limestones have hitherto been regarded as forming the upper division and the dolomitic variety the lower division. Recent work in this field, however, has shown that this method of sub-division is not a sound one, and that dolomitisation is not confined to the lower division. A portion of some fossil collections from the 'Upper' Plateau Limestone has recently been described by F. R. Cowper Reed, who has referred them unquestionably to the Anthracolithic

<sup>35</sup> *Pal. Indica* (in the press).

system.<sup>36</sup> A remarkable feature of the fauna is the large number of peculiar bryozoans, many of which are new species.

In the next higher formation, namely, the Coal Measures, a flora and fauna, of Middle Jurassic age has been obtained thus indicating them to be contemporaneous with the Namyau beds.<sup>37</sup> It is the writer's view, however, that these extensive deposits include at least a portion of the Napeng beds of Northern Shan States. They are succeeded unconformably by Red Beds, the age of which has been fixed through the discovery by C. S. Fox of a few fossils which indicate them to be equivalent to the Trichinopoly beds of the Coromandel coast, which are Upper (Ariyalur) to Middle (Utatur) Cretaceous in age.<sup>38</sup> This discovery is of unusual interest, as no beds younger than Jurassic were hitherto known from the Shan States, excepting the Pliocene-Pleistocene lake deposits. It is noteworthy that after the deposition of the Permian-Carboniferous limestone all the subsequent deposits were laid down in inland seas and large lake basins. These decreased in extent as time went on, until in Pliocene-Pleistocene times the areas of deposition were restricted to isolated lake basins, remains of which are found far and wide in Eastern Asia, including the Shan States, Yunnan, Siam and French Indo-China.

<sup>36</sup> *Rec. Geol. Surv. Ind.*, 1933, **67**, 83.

<sup>37</sup> See Reference 34.

<sup>38</sup> *Rec. Geol. Surv. Ind.*, 1930, **63**, 182.

## Obituary.

Sir Horace Lamb, F.R.S. (1849-1934).

WE regret to record the death of the eminent applied mathematician Prof. Sir Horace Lamb on December 3, 1934 (born on November 27, 1849). He made valuable contributions to the subject of Hydrodynamics; and his first book *Hydrodynamics* (1870) which was published for the sixth time

in 1924 is one of the standard treatises in the subject. In 1884 he was elected Fellow of the Royal Society. He was Professor of Mathematics at Manchester and was recipient of the Copley Medal of the Royal Society in 1924.



Letters to the Editor.

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The Theory of Liquids.

In two recent papers<sup>1</sup> the author has discussed a modification of Edser's theory of liquids which gives equations for the surface tension ( $\gamma$ ) and internal latent heat ( $L_i$ ) as follows:—

$$\gamma = \frac{\mu}{1.31(m-5)\sigma^{m+1}} \quad \dots \quad (1)$$

$$L_i = (4.22 \times 10^{10}) \frac{\mu}{(m-4)\sigma^{m-1}} \times \left[ 1 + \frac{T(m-4)\alpha}{3} \right] \text{ cal/s} \quad \dots \quad (2)$$

( $\mu$ =attractive force coefficient;  $m$ =force index;  $\sigma$ =the average diameter of the spherical space kept clear around a molecule by its thermal movements at  $T$ ;  $\alpha$ =coefficient of thermal expansion). In these equations the effect of the repulsive force, being small, has been neglected.

Although (1) and (2) give results in agreement with observation, they are not altogether satisfactory since the properties of the liquid should be capable of expression in terms of the force constants and  $T$  only. It has now been found possible to eliminate

$\sigma$  from these expressions for  $T_{m,\mu}$  by equating the thermal pressure  $P_T$  to the internal pressure  $P$ . To calculate  $P_T$  it is assumed that at and near the melting point diffusion is slow, and that the liquid molecule vibrates for the most part about its mean position.<sup>2</sup>  $P_T$  can consequently be put equal to the product of:—

(a) the number of molecular centres ( $n$ ) associated with a plane of unit area which is given by the close-packing formula:—

$$n = 2/\sqrt{3}\sigma^2 = 1.15/\sigma^2 \quad \dots \quad (3)$$

(b) the molecular vibration frequency which is assumed to be equal to the frequency in the solid state at the m.p.<sup>3</sup> and is therefore given by Lindemann's equation<sup>4</sup>:—

$$\gamma = 2.5 \times 10^{12} \left\{ \frac{T_{m,\mu}}{M^{\frac{1}{2}} V_{m,\mu}^{\frac{1}{3}}} \right\} \quad \dots \quad (4)$$

$$\text{which as } N\sigma^3 = \sqrt{2} V \quad \dots \quad (5)$$

<sup>2</sup> Cf. Andrade, *Phil. Mag.*, 1934, 17, 477.

<sup>3</sup> Andrade, *loc. cit.*

<sup>4</sup> *Handb. der Phys.*, 1926, 10, 52.

<sup>1</sup> *Ind. J. Phys.*, 1934, 8, 521; *Proc. Ind. Acad. Sci.*, 1934, 1, 105.



can be written

$$\gamma = 4.25 \times 10^{-8} \left\{ \frac{T_{m,\mu}^{\frac{1}{2}}}{M^{\frac{1}{2}} \sigma_{m,\mu}} \right\} \quad \dots (6)$$

( $M$  = mass of a molecule)

and ( $c$ ) the change in momentum suffered by a molecule on approach to the plane which is

$$q = 2M \sqrt{kT/M} \quad \dots (7)$$

We thus have

$$P_1 = n\gamma q = 1.14 \times 10^{-15} \left( \frac{T_{m,\mu}}{\sigma_{m,\mu}^3} \right) \quad \dots (8)$$

It has already been shown<sup>5</sup> that the internal pressure is given by

$$P = \frac{4\pi\mu}{3(m-4)\sigma_{m,\mu}^{m+2}} = \frac{4.20\mu}{(m-4)\sigma_{m,\mu}^{m+2}} \quad \dots (9)$$

Combining (8) and (9) we have

$$\sigma_{m,\mu}^{\frac{m-1}{m}} = \frac{3.68 \times 10^{15} \mu}{(m-4) T_{m,\mu}} \quad \dots (10)$$

Table I shows  $\sigma_{m,\mu}$  (obs.) derived from  $d_{m,\mu}$  (obs.) by means of (5),  $\sigma_{m,\mu}$  (calc.) from (10) and  $d_{m,\mu}$  (calc.) from  $\sigma_{m,\mu}$  (calc.) by means of (5). The agreement is fair when it is

TABLE I.

Calculation of Density at the Melting Point. (10)

Substance	$T_{m,\mu}$	$\mu$ (Proc. Ind. Acad. Sciences, loc. cit.)	$m$	$d_{m,\mu}$ (obs.)	$\sigma_{m,\mu} \times 10^8$ (obs.) (5)	$\sigma_{m,\mu} \times 10^8$ (calc.) (10)	$d_{m,\mu}$ (calc.) (10.5)
He	1.0	$5.77 \times 10^{-60}$	7	0.146	4.02	4.38	0.11
H <sub>2</sub>	13.9	$2.33 \times 10^{-66}$	8	0.077	3.92	3.97	0.075
Ne	24.5	$2.55 \times 10^{-59}$	7	1.250	3.35	3.29	1.33
Ar	83.1	$1.41 \times 10^{-65}$	8	1.419	4.02	3.97	1.46
N <sub>2</sub>	63.0	$2.02 \times 10^{-65}$	8	0.876	4.23	4.35	0.80

considered that it is an attempt to calculate the liquid density at the m.p. from the fundamentals  $T_{m,\mu}$  (observed) and  $\mu$  and  $m$  derived from the gaseous state.

Equation (1) when combined with (10) gives

$$\gamma_{m,\mu} = \frac{(2.07 \times 10^{-16}) [(m-4) T_{m,\mu}]^{\frac{m+1}{m-1}}}{(m-5) (3.68 \times 10^{-15} \mu)^{\frac{2}{m-1}}} \quad \dots (11)$$

Table II shows the application of (11) using values of  $\gamma$  for the lowest temperature observed.

TABLE II.

Calculation of Surface Tension near the Melting Point. (11)

Substance	T	$\gamma$ (obs.)	$\gamma_{m,\mu}$ (calc.) (11)
He	1.5	0.35	0.28
H <sub>2</sub>	15.0	2.8	2.7
Ne	24.7	5.6	7.1
Ar	85.0	13.2	14.9
N <sub>2</sub>	70.0	10.5	10.5

Equation (2) combined with (10) gives

$$(L_i)_{m,\mu} = 11.5 T_{m,\mu} \left[ 1 + \frac{T_{m,\mu} (m-4)a}{3} \right] \text{ calcs.} \quad \dots (12)$$

Table III shows the application of (12).

TABLE III.

Calculation of Internal Latent Heat near the Melting Point. (12)

Substance	T	$a$	( $L_i$ obs.)	$L_i$ calc./ (12)
He	1.75	0.00	18.6	20.2
H <sub>2</sub>	15.0	0.012	189	214
Ar	87.1	0.0046	1326	1530
N <sub>2</sub>	63.1	0.0048	1330	1020

It is hoped to publish elsewhere a more rigorous and elaborate development of the ideas underlying this note.

T. S. WHEELER.

Chemical Department,  
Royal Institute of Science,  
Bombay,  
January, 1935.

<sup>5</sup> Loc. cit.

$d_{m,\mu}$
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WHEELER.

# A Note on the Method of Determining the Heat of Dissociation from a Study of the Long Wave-length Limit of the Continuous Absorption by Gaseous Molecules.

WHEN a molecule is optically dissociated by a single act of absorption one gets a continuous absorption due to the absorbing substance. In order to obtain the value of the Heat of Dissociation earlier workers in the field used to fix the long wave-length limit of absorption simply from eye observations and this apparently led to discrepancies between the values obtained from optical and thermal data. Quite recently A. K. Datta<sup>1</sup> pointed out that better agreement between the two values may be obtained if the limit is sought from the microphotometric curve of the absorption spectrum. According to Datta the long wave-length limit of absorption is independent of the pressure of the absorbing gas and if curves with percentage of absorption and wave-length as co-ordinates be traced for different pressures they should accordingly cut the wave-length axis at the same point. Applying this idea Datta has determined the value of the Heat of Dissociation for a number of gases (HBr, HI, N<sub>2</sub>O, etc.). In case of HBr and HI the values obtained by him agree with the calorimetric values without any discrepancy and from this he concludes that the molecules in these cases dissociate into two constituents without any further excitation of either of them. This would mean

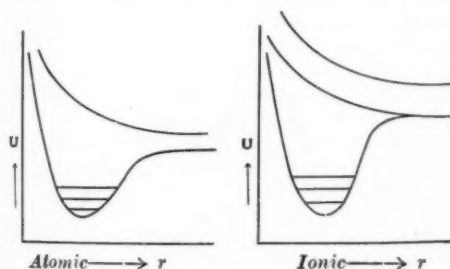


Fig. 1.

that these molecules are of ionic linkage thus refuting the commonly accepted idea, first put forward by Franck, that the Hydrogen halides are dipolar molecules with atomic linkage. In this note our object is to point

<sup>1</sup>P.R.S., 1932, 138, 84; Z.f.P., 1932, Band 77, 405.

out that the determination of the true long wave-length limit of absorption is not very simple. The following considerations will throw some light on the problem. In case of gases giving only continuous absorption, the potential curves for the molecules in the two states are somewhat as shown in Fig. 1.

Since in the process of dissociation, the constituents of the molecules after separation move apart with varying kinetic energies, curves showing the relation between the number of atoms or ions and their kinetic energy would become Maxwellian as shown in Fig. 2. The corresponding curves for the continuous absorption spectrum giving the

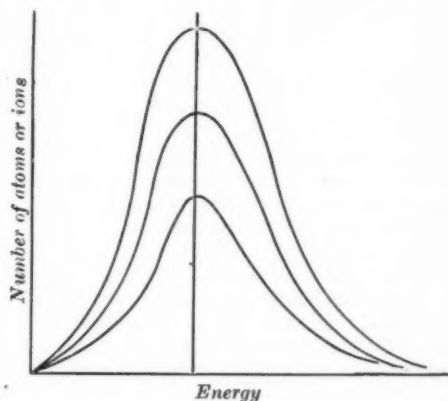


Fig. 2.

percentage of absorption and wave-length would accordingly be similar in nature. From the nature of these curves one can presume that there should be increased absorption throughout the absorbed region with increasing number of molecules and had the fundamental vibration frequency of the molecules been very high so that almost all the molecules could be supposed to be in the normal state of vibration, there would be no variation of the long wave-length limit of absorption with pressure. But if the fundamental vibration frequency of the molecules be not very high as is usually the case, then at the ordinary room temperature the number of molecules in the higher vibrational states would perceptibly increase with pressure and this would necessarily cause a shift of the limit of absorption towards longer wave-length. Besides, an increased pressure would enhance the perturbing influence of the neighbouring

molecules and may also help the process of dissociation by thermal collision, both of which factors may produce a shift towards longer wave-length. From all these considerations one would rather expect, contrary to Datta's observation, a shift of the long wave-length limit with an increase in pressure. Thus, for an accurate determination of the heat of dissociation one has to take account of all these effects and conduct experiments at very low pressures and temperatures with a fairly large number of molecules in the chamber, *i.e.*, with a long column of the absorbing gas.

The experiments with  $N_2O$ ,  $HBr$  and  $HCl$  have been repeated by us with an absorbing column of length 25 inches at various pressures and from microphotometric examination of the plates the long wave-length limit of absorption in each case has been found invariably to shift towards longer wave-length with pressure. Calculating the heat of dissociation from the limits obtained at lowest pressures in our experiments it is found that in every case the optical value far exceeds one from thermal measurements. And this is what one would expect as in thermal experiments usually a large quantity of gas at atmospheric pressure is taken so that there are considerable number of molecules at higher vibrational states which would require on an average a much lesser amount of thermal energy for their dissociation as compared to the condition prevailing in the optical experiments at low pressures. In case of  $HBr$  and  $HCl$ , allowing for the Turner term difference for the halogen atom, a satisfactory agreement is obtained between the two values when photographs are taken at atmospheric pressure. Our observations therefore confirm the original idea put forward by Franck that the hydrogen halides are dipolar molecules with atomic linkages and this is also supported by the fact that there is no record of the second region of selective absorption which one generally finds with molecules of ionic linkages.

A detailed paper will soon be published.

S. DATTA.

B. CHAKROBORTI.

Physical Research Laboratory,  
Presidency College,  
Calcutta,  
January 18, 1935.

#### Constitution of Water in Solutions.

In a previous communication,<sup>1</sup> one of us described the results of investigations on the Raman spectra of water in different state and at different temperatures. Therein, it was found that the changes observed in the structure of the Raman band for water under the various conditions of aggregation and temperature could be satisfactorily explained on the hypothesis of molecular association in pure water giving rise to double  $(H_2O)_2$  and triple  $(H_2O)_3$  molecules in addition to the single molecules  $(H_2O)$ , the equilibrium between which changes with change of state or of temperature, with the result that their relative proportions are different for the different conditions. From a study of the intensity variations in the structure of the band, it was possible to quantitatively estimate these proportions.

That the influence of dissolved electrolytes on the structure of the Raman water band is similar to that of temperature variation was already pointed out from a preliminary study<sup>2</sup> of the Raman spectra of solutions in water of a few strong electrolytes. But a more systematic study was found necessary before any definite conclusions could be drawn as regards the origin of these changes. Such a study was therefore undertaken with a number of solutes belonging to different types of substances, *viz.*, strong and weak electrolytes and non-electrolytes. The following is a summary of the main changes in the structure of the Raman band of water with varying concentration of different kinds of substances dissolved in it.

1. There is a general sharpening of the band with increasing concentration of the substance dissolved, to whichever class it belonged. This phenomenon is similar to that observed with change of temperature of pure water.

2. With increasing concentration of the solute, there is a shift of the centre of the intensity maximum of the band towards larger values of the Raman frequency, excepting in the case of  $HCl$  and chlorides belonging to strong electrolytes, and acetone, which is the only substance pertaining to non-electrolytes that could be studied.

3. The smaller frequency branch of the

<sup>1</sup> I. Ramakrishna Rao, *Nature*, 1933, 132, 480, and *Proc. Roy. Soc.*, 1934, 145, 489.

<sup>2</sup> I. Ramakrishna Rao, *Proc. Roy. Soc.*, 1931, 131, 489.

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band attributed to the triple molecules diminishes in intensity in all the cases thus far studied, except for HCl and chlorides, where the change is not so systematic.

4. With strong electrolytes, different substances dissolved to the same molar concentration revealed differences in the intensity distribution of the band. When, however, the same solutions are studied with the water contained in them equalised, these differences diminished to a large extent indicating thereby that the influence of all substances on the structure of the water band is similar. Yet, certain minor differences in the intensity distribution of the band, which are much more than the probable error in the estimation of intensity, persisted, indicating thereby the small but definite influence of each electrolyte by itself.

5. The solution of each electrolyte with the same concentration studied with increasing temperature revealed an enhancement of the changes in the intensity distribution, these variations with temperature in the structure of the band being most conspicuous for those substances which are known, from chemical evidence, to form hydrates.

The above phenomena are explained on the hypothesis that the changes brought about by increasing proportion of solute are mainly due to changes in the constitution of water, arising out of a change in the equilibrium between the single, double and triple molecules. This hypothesis is strongly supported by the observation that solutions of different substances containing the same amount of water give rise to a Raman band which is almost similar in shape and position for all cases. The minor differences which still persisted are attributed to the formation of hydrates, which is different for different substances. The diminution in the intensity of the smaller frequency portion of the band attributed to triple molecules is taken to indicate the relative instability of the triple molecules compared to the other types at higher concentrations of the dissolved substances.

The temperature variation of the structure of the band with the same concentration of a solute is assumed to be also due to an increasing shift in the equilibrium between the three types of water molecules. The conspicuousness of these changes in the case of substances which are known to form hydrates is explained as being due, in addition to change in the water equilibrium, to dehydration or splitting up of the hydrates

present in solution into single or double water molecules, or of more complex hydrates into simpler ones.

I. RAMAKRISHNA RAO.

C. SAMBASIVA RAO.

Andhra University,

Waltair,

January, 1935.

# Magneto-Resistance Change of Nickel studied with Alternate Currents.

A STUDY of the Magneto-Resistance change of Nickel in Longitudinal Magnetic field, with Direct Currents shows in general a distinct hysteresis effect and also other irregularities.<sup>1</sup> We, however, find a complete disappearance of the hysteresis effect with Alternate Currents. The resistance increases with field showing a saturation value as in the case of Direct Currents; but while in the case of Direct Currents the decrease of resistance with decreasing field shows generally a hysteresis effect and occasionally the reverse of it (i.e., the Magneto-Resistance curve for decreasing field going below that for increasing field), no such effect is however noticed by us in the case of Alternate Currents. We also find that in this case each half cycle is exactly the image of the other, whereas in the case of Direct Currents the half cycles are generally dissimilar unless the sample is demagnetised every time before a resistance measurement is done.<sup>2</sup> The percentage change of resistance, however, when the saturation is reached is of the same order as previously measured with Direct Currents by other investigators including ourselves.

It is important to note here that a similar disappearance of the hysteresis loop in Magneto-Resistance curve has been previously observed even with Direct Currents in the case of electrolytic iron<sup>3</sup> and of Nickel at high temperature.<sup>4</sup>

Work is proceeding to study the problem in all its aspects, and details will be published shortly.

M. M. SEN GUPTA.

H. MOHANTY.

S. SHARAN.

Department of Physics,  
Ravenshaw College, Cuttack,  
January, 1935.

<sup>1</sup> M. M. Sen Gupta and M. S. Alam, *Ind. Jour. Physics*, 8, P. I, p. 9.

<sup>2</sup> O. Stierstadt, *Physical Rev.*, 1931, 37, 1356.

<sup>3</sup> O. Stierstadt, *Zeits. f. Physik*, 1930, 65, 575.

<sup>4</sup> W. Gerlach, *Zeits. f. Physik*, 1930, 59, 847; *Ann. d. Physik*, 1930, 6, 772.



### The Constitution of Vasicin.

In an earlier note<sup>1</sup> we have reported that 3-allyl 4-oxyquinazoline, on reduction with sodium in amyl alcohol, gave a base which was not identical with the similar reduction product of vasicin described by Spath *et al.* It was on this ground that we advocated the rejection of the Spath-Nikawitz formula for vasicin.

Again, we drew attention to the fact that 3-allyl 3:4-dihydrobenz 1:3-diazine of Paal and Stollberg was not identical with desoxyvasicin.<sup>2</sup> We, therefore, welcome the publication of a recent paper by Hanford, Liang and Adams<sup>3</sup> in which both of these statements have been confirmed by new experiments and also by repetition of our own. New evidence against the Spath formula has also been found by showing that 3-allyl 1:2:3:4-tetrahydroquinazoline and dihydro desoxyvasicin are not identical.

Hence the question arises as to what is the correct structure of vasicin.

Hanford *et al* have expressed the opinion that the side chain is in the form of a third fused ring and have proposed two possible structures of which they have expressed preference for one. We would recall that we have already given one of these formulæ as a possibility.<sup>4</sup> Owing to quadrilateral publication from Lahore, Vienna, Oxford and Illinois, confusion with respect to the present knowledge of the chemistry of vasicin has arisen. The position may be summarised as follows:

We established that on oxidation vasicin gives 4-oxyquinazoline thus leaving three of its carbon atoms unaccounted for. Later Spath *et al* observed the formation of 4-oxyquinazoline 3-acetic acid on gentler oxidation and postulated an allyl group attached to the nitrogen atom in a reduced 4-oxyquinazoline.

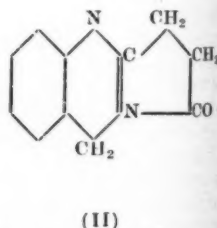
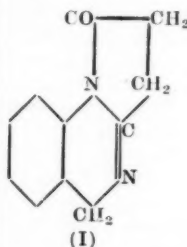
The presence of the allyl grouping has never been definitely established<sup>5</sup> and the non-reduction of vasicin by catalytic means has been duly stressed. The difficulty in assigning a constitution to vasicin arises from

the fact that it has  $\alpha_D = 0$ , therefore a formula must be advanced without an asymmetric atom. The production of 4-oxyquinazoline by oxidation is no proof of the pre-existence of the oxygen atom in this position in vasicin. We have emphasised this point in several previous publications.

It is on this slender experimental evidence that we have to grope for the constitution of vasicin. Naturally, to guess the correct formula one would have to eliminate one alternative after the other. Thus those arriving later in the field will have a natural advantage over the earlier workers. We had clearly stated our position in a previous paper<sup>6</sup> and are still working on the problem of the constitution of vasicin and have covered much ground since last August. However, in view of the publication of Hanford *et al*, we desire to place on record the salient facts which we have established.

We have reduced electrolytically substance (I) and found its picronolate to be different from the picronolate of the electrolytic reduction product of vasicin. This disposes of one of the alternatives suggested by the American authors. We have also found that the picronolates of the electrolytic reduction products of 2-propyl 4-oxyquinazoline and 3-allyl 4-oxyquinazoline are different from reduced vasicin picronolate.

We have also synthesised the substance (II),



and we are engaged in reducing it electrolytically in order to compare its picronolate with that of reduced vasicin. The result should show how far the cyclic structure, at present indicated, is justified. The full experimental details will be published elsewhere.

We trust that this note on our future programme will save duplication of work by other investigators, and hope that we will be able to complete a problem which has

<sup>1</sup> Narang and Ray, *Curr. Sci.*, 1934, 2, 388.

<sup>2</sup> *Cf. Chemistry and Industry*, 1934, 53, 698.

<sup>3</sup> *J. Amer. Chem. Soc.*, 1934, 56, 2780.

<sup>4</sup> *Cf. Narang and Ray, Chem. and Ind.*, 1934, 53, 698.

<sup>5</sup> *Cf. Ghosh, Krishna, Narang and Ray, J.C.S.*, 1932, 2740.

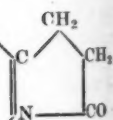
<sup>6</sup> *Chemistry and Industry*, loc. cit.



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received our attention for the best part of three years without being anticipated.

J. N. RAY.  
K. S. NARANG.  
H. R. JUNEJA.

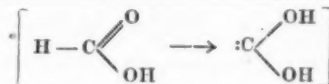
The University,  
Lahore,  
January, 1935.

### Constitution of Formic Acid and Formates.

In order to explain the exceptional behaviour of Formic acid as compared with its homologues the suggestion has been made<sup>1</sup> that in it the ionisable hydrogen is not the hydrogen of the hydroxyl group as in the case of the other fatty acids but the hydrogen attached to the carbon atom. If this could be proved, Formic acid would become not only exceptional among the fatty acids, but would hold a unique position among all organic compounds. A number of substances are known having  $\text{CH}_2$  or  $\text{CH}$  groups the hydrogen atoms of which are reactive. But none of these atoms ionises sufficiently to render the compounds acids.  $\text{HCN}$  could be mentioned in this connection. It is, however, a very weak acid, weaker than carbonic acid and even here probabilities are in favour of attributing the acid character to the isomeric form  $\text{HNC}$ . Consequently the new constitution for Formic acid cannot be accepted as explaining its exceptionally strong acid character. There is also the difficulty of explaining why the hydrogen of the carboxyl group fails to ionise under conditions in which it invariably ionises in similar compounds. Further it should be noted that although Formic acid possesses certain properties not in common with its homologues it certainly exhibits several similarities.

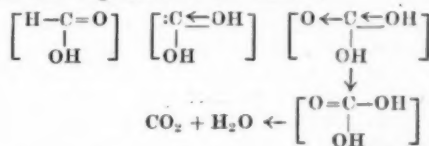
In my opinion the exceptional properties of Formic acid are due to the fact that in it the carboxyl group is linked to a hydrogen atom whereas in its homologues the carboxyl is linked to alkyl groups and that in the course of certain of its reactions Formic acid is capable of undergoing isomeric change into dihydroxy methylene.

<sup>1</sup> Sir P. C. Ray, *Nature*, **133**, 646; P. B. Sarkar, *Indian Science Congress Abstracts*, Chemistry Section, 1935.

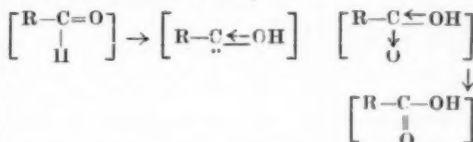


In acetic and propionic acids the alkyl groups act as electron sources inhibiting the removal of a proton from the carboxyl and thus making the substances weaker acids just as halogens and nitro groups act as electron sinks increasing ionisation of the hydrogen and thereby enhancing the strength of the acid. Between the members of the homologous series up to Formic acid there exists only the smaller differences between alkyl groups whereas between acetic and formic acids there is a bigger jump when alkyl groups disappear altogether and a hydrogen atom is present instead.

Though the ionisable hydrogen in formic acid is the one belonging to the carboxyl group there are indications that the other hydrogen atom also is reactive and the compound is capable of assuming the isomeric form given above. In this connection may be mentioned (1) the claim of Scheibler and his co-workers of having produced compounds of the constitution  $\text{C}(\text{OC}_2\text{H}_5)_2$  and  $\text{C}(\text{ONa})(\text{OC}_2\text{H}_5)_2$ ; (2) the behaviour of ethyl formate as an enolisable substance,<sup>2</sup> and (3) the analogous case of hydrocyanic acid which is known to react in two isomeric forms. On this assumption of the dihydroxy methylene form the preparation of Formic acid and all its exceptional properties find easy explanation. Its ready oxidisability can be represented as below:



The oxidation of aldehydes which takes place best in alkaline solutions seems to follow a similar course,



Formaldehyde has been known to exhibit definite though small ionisation of hydrogen.

<sup>2</sup> *Ber.*, 1926, 1031; 1927, 554; 1934, 312.

<sup>3</sup> *Ber.*, 1934, 314.

The old idea of attributing the exceptional properties of Formic acid to the existence in it of an aldehyde group appears, therefore, to be correct.

T. R. SESHADRI.

J. V. D. College of  
Science and Technology,  
Andhra University,  
Waltair,  
February 5, 1935.

### The Effect of the Substituents on the Formation of the Chloralides of Salicylic Acid and Its Derivatives.

WALLACH<sup>1</sup> prepared the chloralide of salicylic acid by heating the components in sealed tube. In contrast to the aliphatic  $\alpha$ -hydroxy acids which form the chloralides very easily, Wallach found that most of the salicylic acid was recovered unchanged. After a very tedious separation, he reported to have got a small quantity of the chloralide which he did not investigate further.

During the course of their work on chloralides, Shah and Alimchandani<sup>2</sup> tried to prepare the salicylic acid chloralide. The condensation was tried under varying conditions in presence of different condensing agents with no advantage. There was no condensation in presence of glacial acetic acid or concentrated HCl, while sulphuric acid gave a product from which no crystalline product could be separated.<sup>3</sup>

The present authors, because it appeared to them that this complexity was due to -OH group in the salicylic acid, studied the condensation with the methyl ether of salicylic acid. The main product of this reaction which has now been thoroughly investigated is 4-methoxy-5-carboxy-1- $\alpha$ -hydroxy- $\beta\beta$ -trichloroethyl benzene, the chloral attaching in *para* position to the -OMe group.<sup>4</sup> This condensation, however, excludes the possibility of the chloralide ring formation because the -OH group has been protected.

The possibility that the reactivity of the free salicylic acid referred to above may perhaps be moderated by the presence of the suitable substituents in the salicylic acid nucleus was next investigated with a

view to get the chloralide of the substituted salicylic acid derivative and then eliminating the substituent to get the chloralide of the salicylic acid itself. For this purpose, we first studied the condensation of chloral with 3-nitro and 5-nitro salicylic acids, (1) by heating the components in sealed tube and (2) in presence of  $H_2SO_4$ . It is interesting to note that although the effect of all the substituents individually and collectively might be expected favourable to the introduction of the chloral molecule in the vacant positions (*ortho* or *para* to the -OH group) or for forming the chloralide ring, the acids were recovered unchanged. A similar experience is recorded by Meldrum and Hirve in case of 3-nitro salicylic acid which resisted all their attempts to sulphonate.<sup>5</sup> The methyl ethers of these nitro salicylic acids behaved similarly towards chloral.

The effect of other substituents like Br,  $SO_3H$  and  $NH_2$  in salicylic acid is being investigated and the detailed results will be published elsewhere.

R. L. ALIMCHANDANI,  
N. M. SHAH,  
S. G. DEO.

Karnatak College,  
Dharwar,  
January 26, 1935.

### The "Non-Protein" Nitrogen of Pulses.

DURING the preparation of globulins and albumins from pulses, there exists, in the saline extract, a nitrogenous fraction, non-protein in character, diffusible through dialysing membranes, non-precipitable by saturation with salts, non-coagulable by heat and indifferent to drastic protein precipitants like trichloroacetic acid. The extensive work carried out on the proteins of pulses relates chiefly to the globulins which occur in them in a predominant proportion and the methods usually employed for their isolation render a recovery of the non-protein nitrogenous fraction, extremely difficult and cumbersome. Further, there are, at the moment, no systematic methods for investigating a mixture of the complexity represented by this fraction. It is therefore not surprising that this valuable fraction has not received any adequate attention at the hands of the several investigators.

<sup>5</sup> J. Indian Chem. Soc., 1930, 7, 887.

<sup>1</sup> *Annalen*, 1878, 193, 1-61.

<sup>2</sup> *J. Indian Chem. Soc.*, 1934, 11, 545.

<sup>3</sup> Chattaway and Calvet, *J.C.S.*, 1928, 1090.

<sup>4</sup> Meldrum and Hurry, *J. Indian Chem. Soc.*, 1934, 11, 535.

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The amount of this fraction which is thus lost, varies from 10 to 55 per cent. of the nitrogen extractable by the saline solution depending upon (1) the nature of the pulse under investigation, and (2) the method adopted for the estimation of the non-protein fraction. It will be observed from Table I that particularly large quantities, 20-55 per cent., are lost during (1) dialysis, and (2) saturation with ammonium sulphate, which constitute the two well-known methods generally adopted for the preparation of proteins.

TABLE I.

	Percentage of Nitrogen lost during isolation of proteins by				
	Ultrafiltra- tion	Trichloro- acetic Acid	Heat Coagu- lation	Dialysis	Saturation with Ammo- nium Sul- phate
<i>Cajanus indicus</i>	14.3	23.5	45.6	25.7	23.6
<i>Lens esculenta</i>	26.1	29.3	46.2	52.1	43.6
<i>Phaseolus aconitifolius</i>	27.6	29.5	40.5	55.3	43.3
<i>Dolichos biflorus</i>	20.7	29.2	55.1	55.2	40.7
<i>Cicer arietinum</i>	12.1	19.1	..	19.6	23.4
<i>Vigna Catjang</i>	11.9	14.5	23.6	25.4	39.8
<i>Dolichos Lablab</i>	16.0	14.9	36.0	..	26.1

The average complexity of the non-protein fraction, as determined by the ratio of the total to amino nitrogen, is given in Table II, which reveals that the non-protein fractions, particularly those obtained by ultrafiltration and trichloroacetic acid precipitation,

TABLE II.

Average Complexity of the Crude Saline Extracts and the "non-Protein" Fractions.

	Crude Extract	Ultra- filtrate	Trichloro- acetic Acid	Heat Coagu- lation
<i>Cajanus indicus</i>	.. 6.4	2.0	2.0	4.0
<i>Lens esculenta</i>	.. 7.1	2.5	2.9	4.8
<i>P. aconitifolius</i>	.. 7.0	2.0	2.7	2.8
<i>Dolichos biflorus</i>	.. 7.4	2.6	2.6	4.4
<i>Cicer arietinum</i>	.. 10.6	3.8	3.5	6.3
<i>Vigna Catjang</i>	.. 10.4	2.3	2.1	3.1
<i>Dolichos Lablab</i>	.. 11.2	2.9	2.6	6.8

contain a high proportion of very simple peptides. The fraction obtained by heat coagulation which represents the nearest approach to the conditions of culinary practice, corresponds to the portion generally administered

to invalids and children. It is particularly interesting to observe that the average complexity of the fractions in general run parallel to the recognised ease of their digestibilities. The non-protein fraction of *P. aconitifolius*, for instance, has the lowest ratio of 2.8 in the heat coagulation series, a fact which is in harmony with the reputation which the pulse enjoys as a very easily digestible and nutritious source of nitrogen during convalescence.

The non-protein fraction of these pulses, therefore, merits a detailed investigation not only with regard to their amino acid make up but also with regard to its possible rôle in influencing the peptisability, increasing the digestibility and supplementing the possible deficiency of the associated protein. An attempt in this direction with regard to the well-known Indian pulses is now being made.

KAMALA BHAGVAT.

M. SREENIVASAYA.

Department of Biochemistry,  
Indian Institute of Science,

Bangalore,

February 7, 1935.

## Synthesis of Vitamin C by Human Infants.

THE observations detailed here were undertaken with a view to see how far there was correspondence in the metabolism in plants and animals in synthesising ascorbic acid from carbohydrates.

Roy<sup>1</sup> has shown that seedlings of pea have the property of converting Mannose to Ascorbic acid to an appreciable extent. Guha and Ghosh<sup>2</sup> have recently found that "in vitro" the isolated kidney, liver and spleen of rats in Ringer solution converts Mannose into "Vitamin C" to a significant extent. Somewhat earlier, Ursula Saunders *et al*<sup>3</sup> showed that like "rats and birds, human infants have the property of synthesising Vitamin C and that this property is maximum at an age of nearly 5 months" diminishing and ultimately disappearing after 14 months.

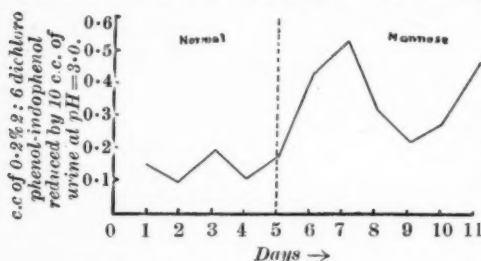
The preliminary observations here described were carried out with a healthy boy of 5-6 months old (author's nephew), entirely breast-fed. The urine passed between the hours of 5 to 11 a.m. was collected

<sup>1</sup> S. N. Roy, *Biochem. J.*, 1934, **26**, 999.

<sup>2</sup> B. C. Guha and A. R. Ghosh, *Nature*, 1934, **134**, 739.

<sup>3</sup> Ursula Saunders *et al*, *Nature*, 1934, **134**, 142.

over sulphuric acid and examined according to Tillman's Technique as modified by Birch, Harris and Roy.<sup>4</sup> The morning urine only was tested following the experience of Johnson and Zilva.<sup>5</sup> As the urine was always almost colourless, the precautions during titration suggested by Emmerie and Eckelen<sup>6</sup> were not necessary. For the first five days the normal urine of the child was daily examined. Then for the next succeeding days the child was given a daily dose of 1 gram Mannose with the mother's milk at 7 p.m. The results observed and graphically represented below are very interesting. The ascorbic acid content under Mannose feeding



showed a considerable amount of increase. A detailed examination of the above results with other details and discussions will be published in the *Transactions of the Bose Research Institute*.

HIRENDRA NATH BANERJEE.

Bose Research Institute,

Calcutta,

January 28, 1935.

#### Starch Accumulation in Stenosed Cotton Plants.

STENOSIS of cotton plants, a malady which has attracted serious attention in recent years, is characterised by a diminution in the size of the leaves. Microscopic examination of sections of tissues revealed that starch had accumulated in the leaves, the vascular bundles of petioles, stems and roots of stenosed plants, while sections of not only the healthy plants but also those of the healthy branches arising from diseased

plants did not show any accumulated starch. The starch content of the leaves was estimated by Allihn's method and the results (on dry weight basis) obtained are given below:

TABLE I.

Material (Leaves)	Per cent. Starch on dry weight basis			
	Preserved in alcohol	Fresh	Ratoon crop preserved in alcohol	Plant partially stenosed
Healthy	13.25	11.00	11.25	12.25
Stenosed	18.30	17.50	15.75	16.75

V. N. LIKHTE.  
G. H. DESAI.

Research Laboratory,  
Agricultural Experimental Station,  
Baroda,  
October, 1934.

#### Production of Dwarf Amphidiploid Tobacco Plants by Hybridisation.

IN crossing *Nicotiana rustica* var. *humilis* ( $2n=48$ ) with *N. glauca* ( $2n=24$ ) the pollen-tubes of *glauca* reach the ovary of *rustica* and fertilisation occurs but the embryos die in a very early stage of embryonic development. In crossing *N. rustica* var. *texana* ( $2n=48$ ) with *N. glauca*,  $F_1$ -hybrid (*N. rustica* var. *texana*  $\times$  *N. glauca*) was produced.  $F_1$ -hybrid developed normally and reached a height of about 150 cm. The same size had the paternal plants growing at the same environmental conditions, while the maternal plant had a size of about 80 cm.

This case shows clearly that the production of species hybrids often depends on the genotype, i.e., on the variety of the species used in the interspecific cross, a phenomenon noted before in *Nicotiana* too (Kostoff, 1930).<sup>1</sup>

The reduction division in  $F_1$  was irregular. Restitution nuclei and dyads were occasionally observed. The hybrid formed about 5-12% viable pollen grains of various size, but it was self-sterile. We selfed flowers of the hybrids and then pollinated the same flowers with pollen from *N. rustica* var. *humilis* or var. *texana*.

<sup>4</sup> Birch, Harris and Roy, *Biochem. J.*, 1933, 27, 590.

<sup>5</sup> Johnson and Zilva, *Biochem. J.*, 1934, 28, 1303.

<sup>6</sup> Emmerie and Eckelen, *Biochem. J.*, 1934, 28, 1153.

<sup>1</sup> Kostoff, Dontcho, *Genetica*, 1930, 12, 33-130.



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From such crosses seeds were produced from which plants were raised. Amongst these plants we found triploids (2 *rustica* genomes + 1 *glauca* = 60 chromosomes), two tetraploids (amphidiploids) with 72 chromosomes, one pentaploid plant with 96 chromosomes (3 *rustica* genomes + 2 *glauca* genomes), and chromosomal aberrants with chromosome number grading from 48 to 70. The triploids were many more (about 40) than the chromosomal aberrants (about 15).

The amphidiploids were dwarfs. One reached a size of about 12 cm. and formed a flower. The latter dropped before setting seeds. The other amphidiploid grew taller and reached a size of about 73 cm., i.e., smaller than the parental plants, *F*<sub>1</sub>-hybrid and the triploids. It flowered and set seeds after selfing. All of the plants grew in the green house at about the same environmental conditions. Special care was taken for the improvement of the growth of the amphidiploid that was about 12 cms. tall, but without any results.

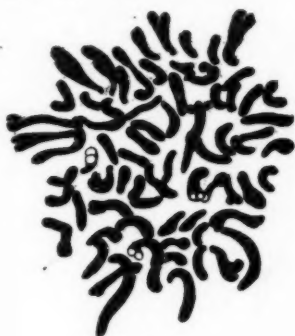


Fig. 1.

A somatic plate from an amphidiploid *rustica-glauc* plant.

The production of dwarf amphidiploids with lower vitality than the parental species, the *F*<sub>1</sub>-hybrid, the triploids, and the majority of the chromosomal aberrants indicates that the amphidiploids, or generally speaking, the tetraploids (*vide* also Kostoff and Kendall, 1934)<sup>2</sup> are not always "giants" and that polyploidy is a limited factor in evolution.

A too great increase of the chromosome number lowers the vitality of the organism. In reality we know very few plants in nature with 200 chromosomes or more than that, and these plants are not "giants" in comparison

to the other species of the same genus having smaller chromosome numbers.

DONTCHO KOSTOFF.

Department of  
Interspecific Hybridisation,  
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Academy of Sciences of U.S.S.R.,  
January, 1935.

### The Life History of *Utricularia coerulea* L.

Of the few morphological studies in the Lentibulariaceae, the work of Wylie and Yocom<sup>1</sup> on the formation of endosperm in *Utricularia vulgaris* is the latest. The following is a brief account of the life-history of *Utricularia coerulea*. The larger paper will be published shortly.

The ovary has an indefinite number of ovules, each with a single massive integument. A single archesporial cell functions directly as the megaspore mother cell and gives rise to the linear tetrad of megaspores, the lowest of which develops into the eight-nucleate embryo sac. The nucellus disorganises very early. The embryo sac begins to grow out of the micropyle (Fig. 1) at the four-nucleate stage, so that finally the egg apparatus lies outside the ovule where the pollen tube meets it. The micropylar end of the sac, which thus lies exposed is in contact with a rich placental nutritive tissue on which it feeds. The antipodal end is tapering and lies in the midst of a chalazal nutritive zone (Fig. 2).

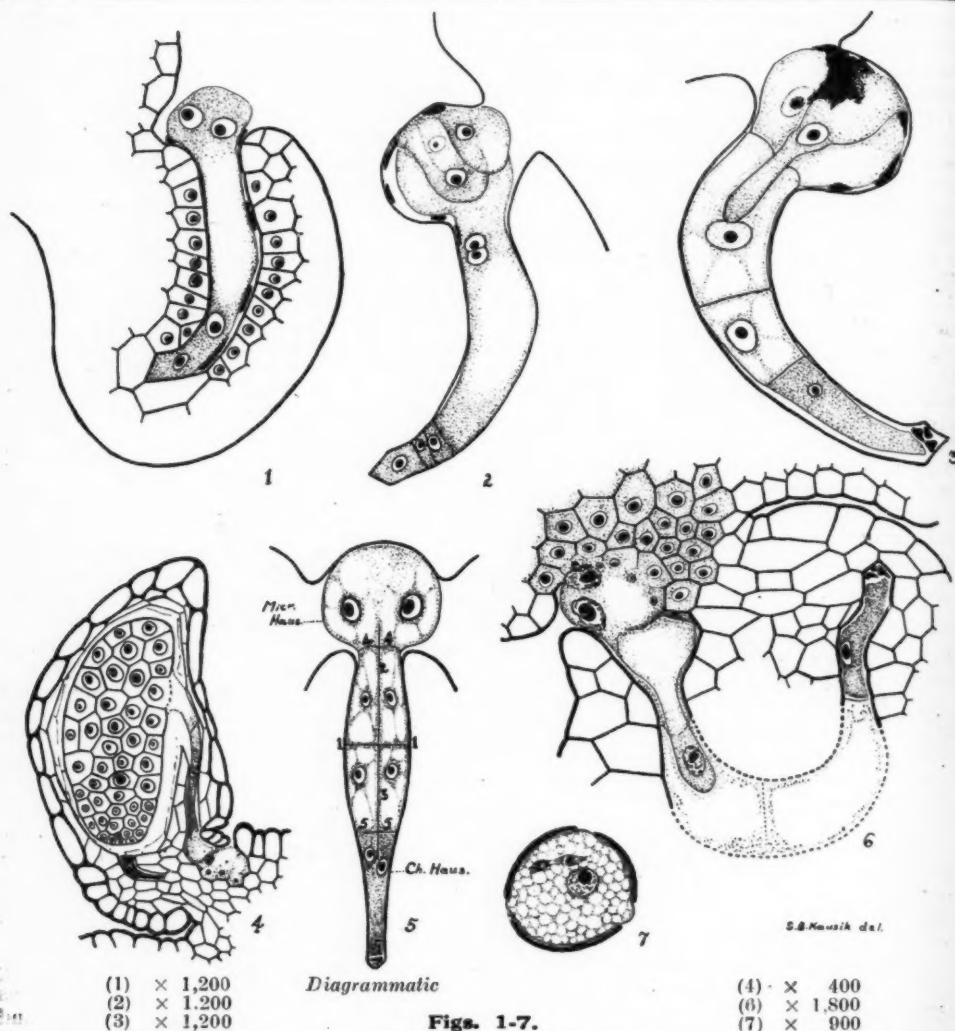
Syngamy is effected in the resting condition of both the egg and the male nucleus, the chromatin of the latter staining more deeply. Variations in triple fusion are observed:—(a) the polar nuclei fusing first and then the second male nucleus entering into the union, (b) the second male nucleus fusing first with one of the two polars, and (c) the two polar nuclei and the male nucleus fusing simultaneously. In all cases the two polar nuclei do not fuse but merely lie close together until the second male nucleus has come in contact with them, and not immediately on the entry of the pollen tube as stated by Wylie and Yocom.

The fertilised egg which is externally situated puts forth a slender tubular growth which entering the micropyle, pierces

<sup>1</sup> Wylie, R. B., and Yocom, A. E. (1923), "The Endosperm of *Utricularia*," (Abstracted from Karl Schnarf's *Embryologie der Angiospermen*, Berlin, 1929.)

<sup>2</sup> Kostoff, Dontcho and Kendall, James, *Gartenbauwissenschaft*, 1934, 9, 20-44.





through the compact cells of the already formed endosperm (Fig. 3). Its nucleus migrates down this tube and the first division takes place at its tip. The formation of a tube from the fertilised egg has not been till now reported in any case. The fully formed embryo which completely fills the cavity of the seed is undifferentiated except for a small group of cells at the apex, the "Vegetationsspitze" of Merz<sup>2</sup> (Fig. 4).

<sup>2</sup> Merz, M., "Untersuchungen über die Samenentwicklung der Utricularien," *Flora*, 1897, **84**, 69-87.

On the division of the primary endosperm nucleus, the embryo sac is first divided by a transverse wall into two chambers, both of which contribute equally to the formation of endosperm. This is said to be of rare occurrence and is thus an important departure from the mode of endosperm formation in *Utricularia vulgaris* which conforms to the Scrophulariaceae type as stated by Wylie and Yocom. The micropylar and chalazal haustoria are differentiated only after the fourth and the fifth divisions respectively (Fig. 5—the numbers indicate the sequence of walls). The haustoria are

binucleate and take an active part in the absorption of nutrition from the placental and chalazal nutritive tissues. After their function is over their nuclei break down (Fig. 6).

The cytology of the pollen mother cells has been worked out in detail. The mode of chromosome pairing is parasynaptic. The haploid number of chromosomes is determined to be twenty. The tetrad of pollen grains is formed by the quadripartition furrows along with vacuolization. The pollen grains at the time of shedding have each a large tube nucleus and two spindle-shaped male cells (Fig. 7).

Grateful acknowledgment is made to Dr. M. A. Sampathkumaran for direction.

S. B. KAUSIK.

Department of Botany,  
Central College,  
Bangalore.  
January, 1935.

#### Proliferation of the Cone in a Species of *Selaginella* from Garhwal.

THE plants were collected in August 1931 by the late Professor S. R. Kashyap from the Alaknanda Valley in Garhwal at a height of about 8,000 ft. above the sea-level, and were kindly handed over to me for investigation. A preliminary paper on the subject was

read by me at the Botany Section of the Nineteenth Session of the Indian Science Congress held at Bangalore in January 1932.<sup>1</sup>

The plants belong to the sub-genus *Stachygynandrum* of *Selaginella*<sup>2</sup> as they possess uniform bracts and ordinary leaves of two kinds and spreading in two planes, those of the upper plane being smaller and more ascending. They show characters closely resembling those of *S. Caulescens* sp. The stem is on the average about 9 inches long, erect and unbranched in the lower half, with spaced adpressed leaves. The spikes are square and the bracts are ovate, cuspidate.

In many cases the homophyllous cone continues to grow and may produce one or two cones in continuation (Fig. 1 *a*, *b* and Fig. 2 *c*) or branch out into two cones at the tip (Fig. 2 *d*, *e*). All these cones have a sterile region at the base, where in many cases the leaves show a clear tendency to revert to the dorsi-ventral arrangement characteristic of the vegetative region, but have not been seen to acquire fully the dorsi-ventral arrangement typical of the purely sterile parts.

In *Selaginella*, as a rule, the cone is

<sup>1</sup> *Proceedings of the Indian Science Congress*, 19th Session, p. 308.

<sup>2</sup> *Baker's Handbook of the Fern Allies*, London, 1887, p. 32.



× 4  
Fig. 1.



× 4  
Fig. 2.

terminal and unbranched. Miss Mitchell,<sup>3</sup> however, has described the following four variations from the normal type: (1) In *S. patula* and *S. cuspidata* "beyond the fertile homophyllous cone the axis continues to grow vegetatively reverting to the dorsiventral structure characteristic of the ordinary stem". (2) In an un-named species, from India, probably *S. pennata*, the same phenomenon was observed "save that abortive sporangia were produced in the axils of the vegetative leaves following the tip of the cone, illustrating the gradual transition between the purely sterile and entirely fertile regions." (3) In *S. erythropus* a second cone was produced on a fertile branch after an intervening sterile region entirely devoid of any vestiges of sporangia, in other words, two definitely fertile regions occurred in the same branch. (4) In *S. oregana* the strobilus is genuinely branched. There is a region with entirely aborted sporangia at the base of the branches, but the leaves of this region retain the external form of the sporophylls.

A genuinely branched strobilus has been described by the writer<sup>4</sup> in *S. pallidissima*, in which sporangia are found in the whole of the branched structure, but are, as a rule, confined to the axils of the sporophylls of the lower plane only, the upper sporophylls being generally sterile.

The nature of the proliferation of the cone in the species from Garhwal described above does not fully correspond with that of any of the cases already recorded, but seems to combine the last two abnormalities mentioned by Miss Mitchell. Fig. 1 shows 2 and 3 definitely fertile regions occurring on the same branch, resembling the case of *S. erythropus*, while Fig. 2 shows genuinely branched strobili like those of *S. oregana*, with the slight difference that the leaves at the base of each fertile portion are sterile and show a tendency to revert to the arrangement characteristic of the vegetative region.

In these proliferated cones there is a tendency of alternation of sterile and fertile zones, which "suggests the condition normally occurring in the more primitive Lycopodiaceae".

S. L. GHOSE.

Botany Department,  
Government College, Lahore,  
January 21, 1935.

<sup>3</sup> *Annals of Botany*, 1910, 24, 21-25.

<sup>4</sup> *Journal of Bombay Natural History Society*, 1917, 25, 281-289.

### The Somatic Chromosomes of *Urginea indica* Kunth.

THE salient points of a paper to be published elsewhere are set forth in this note which deals essentially with the chromosome morphology of *Urginea indica*, a common bulbous plant of the east coast of South India. The somatic number is twenty; all the chromosomes are not of equal size and they exhibit "somatic pairing" (Fig. 1). The complement is resolved into four types on the basis of the size of the chromosomes (Fig. 2).

Details of mitosis which have been worked, show that the early prophase chromatin threads are double and the spiral nature of the chromatids is distinctly visible. The metaphase chromosomes which result from the linear contraction of the chromatids of the prophase threads are made up of two cylindrical halves (chromatids) which are sometimes seen to be hollow, probably an artefact. In early metaphase chromosomes the two limbs are more or less separate except at the region of the constriction while in the full metaphase, they are very closely united. The separation commences at the constriction; hence they are attachment constrictions. The anaphase chromosomes being merely the separated chromatids of the metaphase ones are only single cylindrical structures which sometimes on account of their hollow nature simulate a dual structure. The two edges of the cylinder present the appearance of two parallel threads with a less deeply staining intervening space. The writer is not able to support the chromonema theory which endows the anaphase chromosome with a dual structure and the metaphase one with a quadripartite structure, the chromonemata being supposed to be embedded in an achromatic matrix. The observations recorded herein do not allow of such an assumption.

The characteristic nucleolar behaviour seems to be fragmentation prior to disintegration. It is single to start with, always surrounded by a "halo" and by a process of "budding" separates into a number of bits which finally disappear. Frequently the nucleoli are extruded into the cytoplasm and occasionally they persist upto the late metaphase. These taken together indicate the absence of any direct relation between the nucleolus and the chromatin material of the chromosomes. If anything, it can be considered to be a dehydrated bit of cytoplasm.

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Fig. 1.

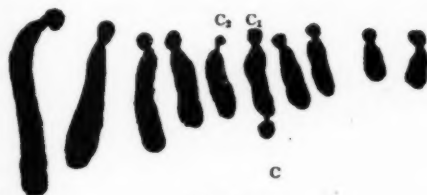


Fig. 2.

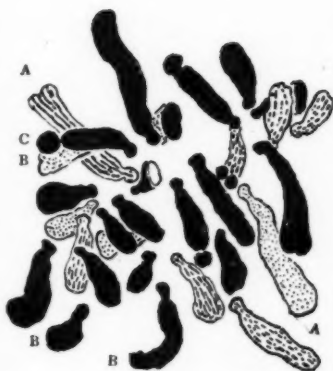


Fig. 3.

A. A pair of long chromosomes with subterminal constriction.

B. Two pairs of chromosomes slightly shorter than A and possessing also subterminal constriction.

D. Two pairs of very short chromosomes with prominent subterminal constriction.

C. Five pairs, intermediate in size between B and D. Of these one pair C<sub>1</sub> shows a secondary constriction at its distal end in the nature of a satellite. In another C<sub>2</sub> the segment beyond the constriction is minute.

Triploidy has also been observed; the chromosomes occur in sets of threes in the complement (Fig. 3).

T. S. RAGHAVAN.

Annamalai University,  
Annamalainagar,  
January 20, 1935.

**Polyembryony in *Murraya kænigi* (Spreng).**

THE phenomenon of polyembryony has been observed till now as far as information could be gathered in only two genera of the family Rutaceae. They are Citrus, and Xanthoxylon. In both these cases the additional embryos take their origin from the nucellus. In Xanthoxylon,<sup>1,2</sup> fertilization does not take place. In Citrus,<sup>3</sup> fertilization has been observed and the normal embryo also develops. While working last year on the Cytology and Morphology of some Rutaceae it was noticed that a third genus of this family, *Murraya*, exhibited this interesting feature.

The embryo sac of *Murraya kænigi* is of the normal 8-nucleate type. Fertilization has been observed. The egg divides late by which time the endosperm will be in the free nuclear state. It can be seen now that most of the cells of the nucellus at the micropylar region stain dark. They are all potentially embryogenous and most of them undergo further development. But only those embryos that lie on or very near the border of the embryo sac cavity project into it and continue to develop further (Figs. 1 & 2, from sections of the same ovule and Fig. 3). Thus numerous nucellar embryos develop side by side with the normal one, leading to intense overcrowding which in cases makes it difficult to demarcate individual embryos in a group. The normal embryo can be distinguished usually from the nucellar embryos by the presence of a suspensor. Serial sections of a fairly mature seed show 2 or 3 embryos with developed cotyledons, and 10 or more others which have projected into the embryo sac cavity but with no cotyledons, and still more numerous embryos embedded in the nucellus (Fig. 4).

<sup>1</sup> Schürhoff, *Der Zytologie der Blüten Pflanzen*, 1926.

<sup>2</sup> Schnarf, *Embryologie der Angiospermen*, 1929.

<sup>3</sup> Osawa, "Cytological and Experimental Studies in Citrus," *Coll. Agr. Tokyo*, 1912, 2.

A rigorous developmental selection seems to operate in the embryogeny of *Murraya kænigi*. Though a large number of nucellar embryos take their origin only some 10-12 successfully develop further in the embryo-sac-cavity. Of these successful ones only 2 or 3 develop the cotyledons. The rest of

the embryos are arrested in their growth at earlier stages of development.

R. S. CHAKRAVARTHY,

Central College,  
Bangalore,  
February 2, 1935.

Fig. 1.  $\times 240$ .

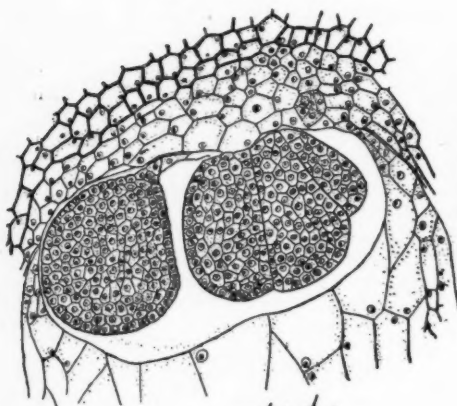


Fig. 2.  $\times 240$ .

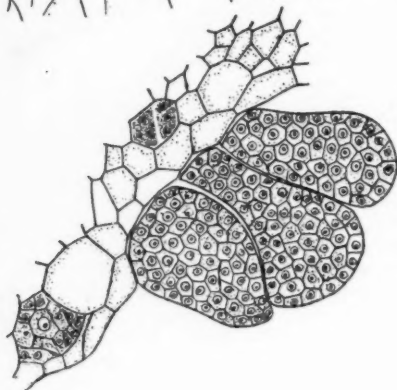
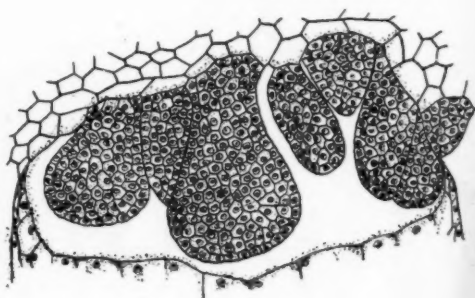


Fig. 3.  $\times 280$ .



Fig. 4.  $\times 80$ .

#### Bulbils in Sorghum.

THE ordinary sorghum is from a single-seeded spikelet. There are some races in which the spikelets bear two seeds and occasionally three. In the case of two grains the extra one is borne in the axil of the third glume which develops a palea of its own. When three grains occur the third one is formed by the twinning of the usual grain in the fourth glume. In the second

generation of certain crosses between double-seeded and single-seeded varieties small greenish bodies were noted in the spikelets at the pre-ripening stages. The whole population was examined and this curious phenomenon was confined to 8 plants in a total of 674. In these eight plants, 22 such structures were noticed, the maximum being three in a head. The spikelets were examined and it was noticed that these green bodies



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were tiny bulbils resulting from the conversion of one of the grains into a leaf-like structure (see illustration). The bulbils ranged from 0.5 to 3.5 cm. in length, the most frequent being 2.5 cm. The pathological origin of these bulbils was suspected but a microscopic examination of the tissues did not reveal any such cause. Eight of the longest of these bulbils were planted out and nursed but none of them showed any tendency to live on. The rest of the spikelets were teased out and it was noticed that they were in structure like any other bulbil with 4-5 completely inrolled leaves which showed a progressive increase in length towards the top.

The occurrence of bulbils in both monocotyledons and dicotyledons has been record-



Sorghum-Bulbil.  $\times 4$

ed. In the Gramineæ their occurrence has been noted in some genera. These bulbils vary in composition. They may be entirely leafy, have sessile flowers in the axils of their scale leaves, or have stalked flowers, resembling a miniature plant. The floral structures when present may have imperfections of degrees. In almost all cases these bulbils

have been in the nature of a device at reproduction evading possible risks run by a direct propagation through seed. This instance of bulbil formation in grain sorghum lends to two possible explanations. The phenomenon of bulbil formation may be a premature index to prolificness, which doubling and trebling of grain connotes or may be in the nature of a primitive bent which some of the ancestors of sorghum may have had recourse to in their original habitat. A wide survey of the key regions of this Great Millet may throw helpful light in the interpretation of the occurrence of this rare phenomenon brought about through wide hybridisation.

G. N. RANGASWAMI AYYANGAR.  
V. PANDURANGA RAO.

Millets Breeding Station,  
Coimbatore.

January 21, 1935.

#### Sclerospora Sp. and Suppression of the Awn in Sorghum.

SCLEROSPORA has been known to attack Maize Teosinte, Sorghum, Bajri, and the Italian millet. There are records of the many effects of this infection on the host plant. In Maize, dwarfing of the plant, shortening of the internodes, chlorotic leaves, late heading, small cobs, absence of grain and a wide range of fasciations, phyllodies, reduplications and virescences have been observed. In Teosinte, sterility in spikelets, absence of stamens, withered anthers, non-functional pollen, proliferated florets are on record. In Bajri (*Pennisetum typhoides*), the pearl millet, it has been noted that the panicle is the most susceptible part. The upper segments of the floral axis get converted into a leafy shoot. Bristles become hypertrophied. Stamens get modified into a leaf-like body with sheath and blade. The pistil never develops.

In Jowar (Sorghum) it has been noted that the vegetative parts are more susceptible to this disease. The leaves turn yellow and shred. Earheads are produced with difficulty. They are small and have small grains. At the Millets Breeding Station, Coimbatore, one of the effects of this disease has been a shortening of the panicle branches, resulting in a more compact-looking earhead.

In the summer of 1931 a five tillered Sorghum plant in a long awned variety was noted to have one of its earheads without

awns. One young tiller was very badly affected with *Sclerospora* and did not flower. The other four tillers produced earheads. Three were normal with long awns, the awns being 7—9 mm. in length. The fourth earhead was small and its glumes did not have awns. The leaves of this tiller were shred. This head showed signs of late and weak anthesis. Its flowers were teased and it was noted that the stigmas were flabby and the lodicules and ovary shrunken. The anther lobes had shrivelled walls. Most pollen grains were plasmolysed, empty or collapsed. Such of those as were healthy had germinated *in situ*—a remarkable fact—showing small tube growths. Malformed anthers were noted and in one case the atrophied anther lobes had no filament but were attached alongside of the short narrowing tip of a sessile spike-like body, probably homologous with the filament. The ovarian tissues were found to have been penetrated by a felt of mycelium.

The most noticeable feature of this attack is the suppression of the awn. It has been noted that the leaf-blade is the most susceptible part of the *Sorghum* plant in the attack by *Sclerospora*. Terratological and morphological evidences lead towards considering the awn as being homologous with the blade of the leaf.<sup>1</sup> This suppression of the awn as a pathological effect is therefore interesting. It has been noted that in one of the plants raised by pollinating with irradiated pollen there was a suppression of a majority of the leaf-blades.<sup>2</sup> The suppressions in the above instances lead to the interesting problem of tracing the affinities between direct pathological reactions and the induced suppressive effects of irradiation. In either case the susceptibility of the blade-awn organs and the comparative individuality of the sheath-glume structures (protecting buds and embryos) lead to interesting possibilities in the pursuit of the evolutionary factors operating towards a differentiation of the leaf into blade and sheath and their homologues.

G. N. RANGASWAMI AYYANGAR.  
P. V. HARIHARAN.

Millets Breeding Station,  
Coimbatore,  
January 21, 1935.

#### On the Discovery of a Prehistoric Fossil Elephant in the Allahabad District.

THE news of the discovery of a 31 feet skeleton of some prehistoric animal in the Daiya estate (district not mentioned) was published in the *Leader* about six months ago. A similar report came out in some newspapers early in December last, but the place of occurrence was given as 'Datia State' in one paper and 'Doyra State' in another. On enquiry it was found to be Daiya estate towards the south-eastern part of the district of Allahabad.

The skeleton was found in the bed of a streamlet known as Tundiari Nala. The spot is about half a mile to the south-east of the village Murlipur (Lat. 24° 52', Long. 82° 3'). A part of the skeleton exposed in the bed of the streamlet was first seen by some cowboys during the last summer. The landlord of the estate, Raja Bhagawati Prasad Singh, got the skeleton dug out in parts, as soon as the discovery came to his notice. On local enquiry the author learns that the fossil animal was found lying on its back, the head and forelimbs pointing upstream and the hind-limbs downstream. Parts of the limb bones were missing. The tusks were not in organic connection with the head. A part of one tusk was lying in the same line with one of the hind-limbs. This was included in the measurement of the animal, which the villagers took to be a giant human individual. This mistake was possible because the skeletal parts are not well preserved and the facial features were concealed by the matrix.

The animal concerned appears to be a representative of *Palaeoloxodon namadicus*, an extinct species of elephant which is supposed to be more closely related to the living African elephant than the living Indian species. The type for this species is a very perfect specimen of a cranium figured (Pls. XIA, XIIB) by Falconer and Cautley in the "Fauna Antiqua Sivalensis" under the name of '*Elephas (Euelephas) Namadicus*'. The specimen was obtained from the Narbada alluvium and is preserved in the British Museum. The bulk of the material referred to this species comes from different localities situated along the Narbada valley. But a specimen was discovered in the Godavari alluvium also. A few molars are reported to have come from the Irrawaddy valley in Burma, but no definite history of this find is available. Outside

<sup>1</sup> *New Phytol.*, 1934, **33**, 359.

<sup>2</sup> *Madras Agric. J.*, 1934, **22**, 448.

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India, the species is known from China, Japan and Java. This species resembles a variety of *Palaeoloxodon antiquus* of Europe, which is characterised by broad-crowned molars; and by some authorities they are regarded as identical.

The present discovery is particularly interesting in view of the fact that it has been made in a country covered by rocks belonging to the Vindhyan System. At the site of occurrence the streamlet cuts through a *Kankar* bed, which is probably an alluvium formed during the middle or the latter part of the Pleistocene epoch. This formation is exposed at the bed from where the skeleton was excavated, and also at the vertical cliffs on the two sides having a height of 12 feet and above.

The skeleton has been presented to the Geological Museum of the Benares Hindu University. An anatomical study of the specimen is in progress, and a description will be published in due course.

D. K. CHAKRAVARTI.

Geological Museum,  
Benares Hindu University,  
January 30, 1935.

**On the Occurrence of Foraminifers and Radiolarians in the Infra-Trappean Limestones near Pangadi—Rajahmundry.**

It is well known that the only detailed account of the infra- and inter-trappean rocks of the Rajahmundry area is the one published by William King<sup>1</sup> so far back as 1880. During a recent visit, we have been able to collect a number of limestones associated with the Deccan traps of this area. In the course of a microscopic examination of these rocks, it is found that some of the infra-trappean limestones found near Dudukur and Gowri-patnam reveal the presence of numerous foraminifers and a few radiolarians in them—one type of limestone particularly—being almost wholly composed of foraminiferal shells. Most of these foraminifers belong to the family Rotaliidae—the common forms being *Rotalia*, *Discorbina* and *Pulvinulina*. A few shells of *Globigerina* and one or two types of *Miliolines* are also recognisable.

These micro-organisms from the infra-trappean limestones resemble in their general character, those described sometime back by

Prof. L. Rama Rao<sup>2</sup> from some of the rocks of the Utatur division (Cenomanian) of the Trichinopoly Cretaceous.

A detailed account of the micro-organisms from the limestones under study will be published elsewhere.

S. R. NARAYANA RAO,  
K. SRIPADA RAO.

Department of Geology,  
University of Mysore,  
Mysore,

February 3, 1935.

**On the Nomenclature of Lac Insects.**

FOR reasons of priority Cockerell\* suggested that the name *Laccifer*, Oken, should be adopted for designating the genus of the lac insect. Before Oken, Roxburg published an article entitled, "On the Lacsha or Lac insect", which appeared in two forms. It first appeared in the *Asiatic Researches*§ with an introduction by Anderson, who wrote to Sir William Jones, the Editor, that, "Roxburg's discovery will bring lac, a genus, into the class Hemiptera of Linneus". Now Anderson himself had discovered and named the wax insect, *Ceroplastes ceriferus*, while Roxburg was then the most renowned systematic botanist in India. As energetic systematists they must have understood how to bring a new genus to include the lac insect into the Linnean system of nomenclature.

But Sir William Jones was personally interested in utilising Sanskrit names for a scientific vocabulary and had actually written an article creating some examples and demonstrating such a possibility. Either Roxburg and Anderson, knowing Sir W. Jones's keen interest, left the matter to his decision or the latter changed it to *Lacsha* for, as though he was offering an explanation for his choice, he endorses saying, "the Hindus have six names for lac but they generally call it *Lacsha*".

Roxburg's article, without Anderson's foreword, was published in *Phil. Trans.*, 1791. This had a much wider circulation than *Asiatic Res.*, and Oken remained absolutely unaware of any previous desire on the part of a systematic biologist to bring the lac insect into the class Hemiptera of Linneus.

<sup>2</sup> (a) *Quart. Journ. Geol. Min. Met. Soc., Calcutta*, 1931, 3, No. 2; (b) *Journ. Roy. Micro. Soc., London*, 1932, 52, 357-361.

\* *Psyche*, 1924, 31.

§ *Asiatic Researches*, 1790, 2.

<sup>1</sup> *Mem. Geol. Surv. of India*, 1880, 16, Pt. 3, 37-54.

It is unfortunate that most writers who have accepted the name *Laccifer* have had no access to the complete article of Roxburg.

Sir W. Jones would prefer a purely Indian word, *Lacsha*, but the name suffers from the disadvantages of being common place in a land like India where it already connotes an article of household use. It is suggested that *Lakshadia* would be more appropriate as a generic name while *Lacsha* has all the claims of priority over *Laccifer*.

S. MAHDI HASSAN.

"Abid Manzil,"  
Hyderabad (Deccan),  
January 25, 1935.

#### Wax-Production in Aleurodidae.\*

THE secretion of wax is a very commonplace phenomenon in many of the Homoptera and is particularly noticeable in all the families of Sternorrhyncha. Wax is secreted by special structures known as *wax-glands*, *wax-cells* and *wax-pores*. The arrangement, position and structure of these may differ in different families. The secretion of wax is found in the larval as well as in the adult stages. In the family Aleurodidae, wax-secretion is profuse in the adults of all the species, but not found to the same extent in the larvæ. Generally three types of wax-pores are found in the larvæ of Aleurodidae—(1) Simple, (2) Agglomerate, and (3) Compound. The structure of the simple and compound wax-pores is as follows:—

Simple wax-pores are circular holes of small or large size in diameter from .017 mm. to .027 mm. These exist in greater numbers in those species which secrete a large quantity of wax. In compound pores the holes have a chitinous ring surrounding them and a definite elevated cup-like structure. Within the cup the pores are arranged in a ring and are produced into more or less elevated rods or tubes.

In the Adults there are chitinous plates which are placed ventrally on the abdominal segments and are known as wax-plates. These may be comparable to the wax-plates in honey bees. There are two pairs of these plates in the female placed on the 3rd and 4th segments respectively and four pairs in the male on the 3rd, 4th, 5th and 6th

segments. These wax-plates appear like thick pads and are oily yellow in appearance. They are separated by a median line in the centre of the abdomen but extend considerably outwards on both sides so that they can be very clearly seen laterally as they are bounded by a black line.

In the female both the plates appear to be equal in dimensions, but in the male the first one is bigger and the succeeding ones gradually reduced in size. When viewed under microscope these present an appearance of plates possessing minute holes arranged in regular rows.

When highly magnified (1,200 times under the oil-immersion lens) these holes appear like cells in a honey comb. These are the minute circular pores through which wax comes out or is forced out in small minute particles or threads. In thin microtome sections taken through these wax-glands there is seen a single layer of secreting cells with large nuclei which contain vacuoles. There are numerous granules in these vacuoles which are found in a large number towards the outer side.

A careful examination of these plates in a male of *T. vaporariorum*, under a very high magnification, shows that each of the last three plates contains 40 rows of 90 cells each at an average; the first one has 50 rows as it is larger. Thus the total number of pores of one side comes to  $3,600 \times 3 = 10,800$  plus  $50 \times 90 = 4,500 = 15,300$  or approximately 15,500 and both the sides together will bring the number to 31,000. Each side on the abdomen the space occupied (longitudinally) is .3 mm. In the female there are only two pairs of plates which are rather broader and occupy space to the extent of .23 mm. each side. Each of the plates contains pores in rows of  $63 \times 95$  and  $60 \times 95$  cells respectively. The total number of pores on one side thus comes to 11,685 or nearly 12,000. It is not understood why the number of pores is less in females.

Freshly hatched specimens are perfectly free from any wax particles soon after emergence. The wax-plates, not being at work, cannot be marked out very clearly.

I give below my observation on a specimen for about 5 hours from its emergence. It was a male. It extricated itself with great difficulty from the pupal case which operation took about an hour. This was at 10 a.m. In the first two hours no wax was seen being secreted but only the wax-plates assumed an oily olive appearance.

\* These observations were made on *Trialeurodes vaporariorum*—the greenhouse white fly—at Edinburgh, under Dr. C. B. Williams, now the Chief Entomologist, Rothamsted, England.



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Then one of the plates (on the left side) was seen covered with white flocculent material which soon after drying became white. The insect (which was under a binocular) was actively moving its legs first of one side and then of the other. In that way the legs actually brushed off the wax accumulated on the plate and by dashing the legs here and there it distributed the wax or the meal all over the body.

As the plates on the left side were active, the left side of the body was covered with wax, first the abdomen and its end, then the underside of the wings and then the front part of the body. Gradually all the plates began to secrete wax which was being spread all over the body. All the plates were in full action by 3 p.m., i.e., 5 hours after emergence.

The structure of the meal or the wax secreted is very peculiar. It is in the form of spiral threads as if forced out through small holes, but under abnormal conditions, or if the meal is not constantly removed by the brushes on legs, it assumes the form of long threads appearing like silken combs or tufts. While observing the eclosion of flies from the pupæ, I have seen several specimens with three-fourths of their body out and struggling hard to extricate the last part of the body. The insect is standing erect and dashing its legs in the air and with wings in the unexpanded condition. The wax-plates are active and the wax begins to appear on the body. As no brushing off is possible in that condition, the wax goes on accumulating and a very thick brush-like layer is formed.

Under microscope these appear like bunches of long threads with one end curved. I have also observed cases of partial emergence wherein the flies have died after the upper part of the body head and thorax having come out and the abdomen remaining inside the pupal case. In such cases I have found after pulling out the abdomen that it was full of waxy brushes, proving thereby that the wax-plates were actively secreting wax even if the abdomen was enclosed in the pupal covering.

V. G. DESHPANDE.

Department of Agriculture,  
Bombay,  
January, 1935.

# Hermaphroditism in *Lycastis indica* (Southern).

HERMAPHRODITISM in Polychæta is of such rare occurrence that only about a score of forms are known to be bisexual out of several hundreds of species described. Most of these belong to families Sabellidæ and Nereidæ and among the latter, *Lycastis quadraticeps* (Gay) has been described by H. P. Johnson<sup>1,2</sup> from the Straits of Magellan on the Chilean coast, as exhibiting the phenomena of hermaphroditism and gigantic ova. Many species of *Lycastis* have been recorded in recent years mostly from Sumatra and Java, the genus now consisting of about a dozen distinct species, leaving out one or two doubtful cases. With the exception of *Lycastis brevicornis* (Aud et M. Edw., 1832-34), first described from the coast of France but which has not been rediscovered, all the known species are from the tropics. They are capable of enduring great variations in salinity and sometimes even enter fresh-water and many of them are gradually getting themselves adapted to life in wet mud like earthworms. *Lycastis indica* (Southern), the only known Indian species of this genus, is common in the backwaters of Cochin, Madras and Calcutta and several other places in India and probably also has a much wider coastal distribution than is at present known. In Madras the author has seen it inhabiting situations where the salinity is nearly as high as that of the sea and more frequently in places where the water is almost fresh, the species having been taken even from pools of fresh-water near Adyar.

The worms usually attain a size of 20 to 25 cms. Gonads develop rather early in life. Thorough examination of some hundreds of specimens reveals that *Lycastis indica* is hermaphrodite and protandrous. The male sexual elements appear first and when young the worms pass through a male phase, the body cavity now containing masses of motile spermatozoa only. The ova develop later in life, both motile sperms and mature ova occurring in almost all the segments, the worm now being truly hermaphrodite. This

<sup>1</sup> Johnson, H. P., "Fresh-Water Nereids from the Pacific Coast and Hawaii with General Remarks on Fresh-Water Polychæta," *Mark Anniversary Volume*, 1903, 205-223.

<sup>2</sup> Johnson, H. P., "*Lycastis quadraticeps*, a hermaphrodite Nereid with gigantic ova", *Bio. Bull.*, 1907-8, 14, 371-386.

condition is observed in all the full-sized worms. A detailed account of the life-history and the bionomics of this interesting Nereid will be published shortly.

R. GOPALA AIYAR.

University Zoological  
Research Laboratory,  
Madras.

January, 1935.

**The Existence of the Intervertebral  
Ligament in the Vertebral Column of a  
Perennibranchiata (*Necturus maculatus*).**

GADOW<sup>1</sup> has stated: "In many Urodela, especially in the Perennibranchiata, the whole intervertebral cartilage acts as the joint, being, in fact, a flexible mass intercalated between the bases of the hollow calcified cones of the successive vertebrae. However imperfect this joint may be, it does fulfil the requirements of these long-bodied and long-tailed aquatic Urodela."

Subsequent authors like Schauinsland,<sup>2</sup> Kingsley<sup>3</sup> and Goodrich<sup>4</sup> have supported the statement of Gadow.

On examining an adult specimen of *Necturus maculatus* we found that its body is quite flexible like that of an ordinary teleostean fish. This led us to reinvestigate the development of the intervertebral elements of *Necturus maculatus* and we have found the existence of an intervertebral ligament like that of the fish.

Mookerjee<sup>5</sup> has shown that in all Vertebrata the skeletogenous layer aggregates round the notochordal sheaths forming the perichordal tube. The same author<sup>6</sup> has shown for the first time in a higher Urodela, such as in *Triton vulgaris* that the Vertebral portions of the perichordal tube soon becomes osseous forming a series of hour-glass-shaped bony rings while the intervertebral regions of it remain cartilaginous. Each intervertebral cartilaginous ring is

overlapped by the osseous vertebral rings; but the overlap of one does not meet the overlap of the next, so that the middle of the intervertebral cartilage ring remains unprotected. A strand of migratory connective tissue cells grows into the cartilaginous perichordal ring in a caudal to cranial direction forming a complete arc through the interspace between the two successive hour-glass-shaped centra, and then a split appears within the line of this arc of connective tissue cells, thus forming a synovial cavity. The intervertebral cartilage is divided into a ball and socket; the ball articulates with the front end of a vertebra and the socket with the posterior end of the previous vertebra. The connective tissue cells lining the synovial cavity become cartilaginous, forming the surfaces of the ball and socket. So each vertebra has a ball in front and a socket at the back forming an ophisthocœlous vertebra.

Graham Kerr<sup>7</sup> has stated that the intervertebral cartilage in Urodela increases considerably in thickness, bulging out between the adjacent somewhat expanded ends of the bony tube. The statement of Graham Kerr is incorrect as one could easily see that in an early stage these migratory connective tissue cells are outside the intervertebral cartilage and at a later stage they could be seen migrated within the intervertebral cartilage.

In *Necturus maculatus* an almost identical condition can be seen with certain modifications. After the formation of the hour-glass-shaped centra and the cartilaginous intervertebral rings, the migratory connective tissue cells instead of getting in an arc, go inside it at right-angles to the rings. These connective tissue cells soon become a ligament. A transverse section through the anterior region of the intervertebral cartilage of the trunk region of *Necturus maculatus* at 48 mm. stage, shows the cartilaginous cells outside the notochordal sheath which is surrounded by the osseous ring of the hour-glass-shaped centrum which overlapped on the intervertebral cartilage (Fig. 1). A section passing through the middle region of the intervertebral cartilage which remains unprotected, clearly shows that the migratory connective tissue cells have entered inside the intervertebral cartilage and have constricted the notochord considerably.

<sup>1</sup> Gadow, H., *Phil. Trans. Roy. Soc. (B)*, 1896, 187, 1-57.

<sup>2</sup> Schauinsland, H., *Handbuch der vergl. u. experim. Entomologie der Wirbeltiere von Oskar Hertwig*, 1906, 3, 339-572.

<sup>3</sup> Kingsley, J. S., *The Vertebrate Skeleton*, 1925, 38.

<sup>4</sup> Goodrich, E. S., *Studies on the Structure and Development of Vertebrates*, 1930, 51.

<sup>5</sup> Mookerjee, H. K., *Nature*, August 4, 1934, 134, 182.

<sup>6</sup> Mookerjee, H. K., *Phil. Trans. Roy. Soc. (B)*, 1930, 218, 415-446.

<sup>7</sup> Graham Kerr, J., *Text-book of Embryology*, 1919, 2, 299.

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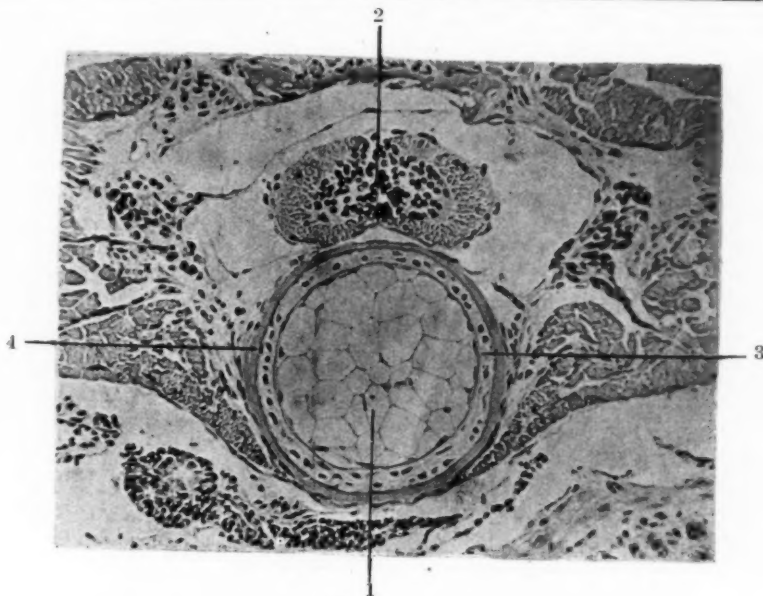


Fig. 1.

Transverse Section through the anterior region of the intervertebral cartilaginous ring of a trunk vertebra of *Necturus maculatus* at 48 mm.  $\times 90$ .

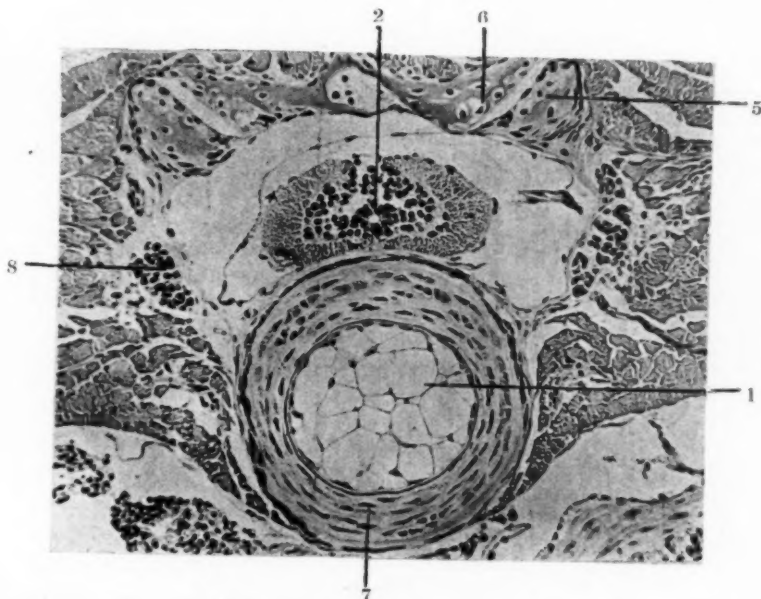
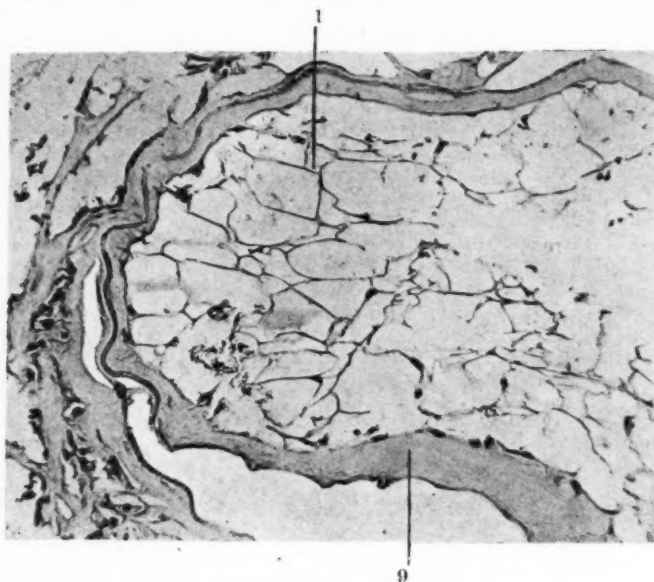
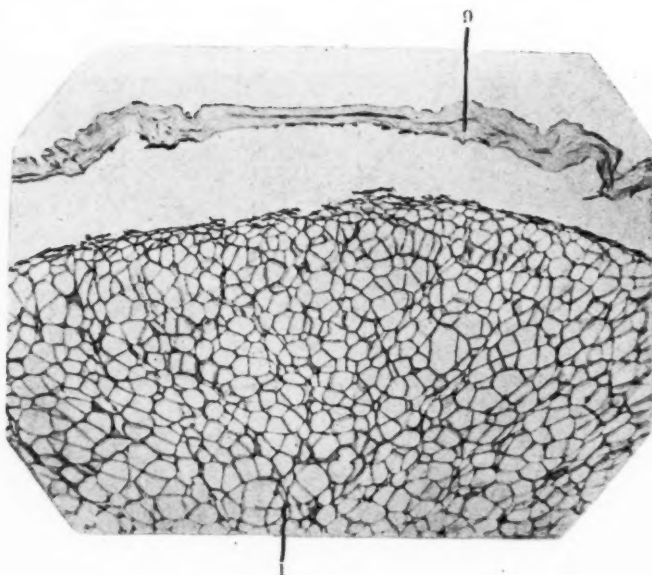


Fig. 2.

Transverse Section through the middle region of the intervertebral cartilaginous ring of a trunk vertebra of *Necturus maculatus* at 48 mm.  $\times 90$ .

**Fig. 3.**

Transverse Section through the intervertebral ligament of an adult *Necturus maculatus*.  $\times 100$ .

**Fig. 4.**

A part of the Transverse Section through the intervertebral ligament of an adult *Labeo rohita*.  $\times 70$ .

1. Notochord; 2. Spinal cord; 3. Cartilaginous intervertebral ring; 4. Osseous vertebral ring; 5. Pre-zygapophysis; 6. Post-zygapophysis; 7. Migratory connective tissue cells inside the middle region of the intervertebral ring; 8. Spinal nerve ganglion; 9. Intervertebral ligament.



These migratory connective tissue cells are responsible for the formation of the intervertebral ligament (Fig. 2). For the sake of comparison we have given a transverse section of the intervertebral ligament of an adult *Necturus maculatus* (Fig. 3), and a part of a transverse section of the intervertebral ligament of an adult fish *Labeo rohita* (Fig. 4). From these two figures one can easily make out that they are almost identical structures. The evidences that are before us lead us to believe that the previous workers did not trace the development of the vertebral column of Perennibranchiata up to its maturity, otherwise they would not have missed the existence of the intervertebral ligament. Of course the connective tissue cells that

migrate inside the intervertebral cartilage were unknown to them.

In conclusion we may say that aquatic animals like *Necturus maculatus* would not have been able to protect themselves from their powerful enemies had they not had a very flexible body in order to change the direction at a moment's notice when they were chased by their deadly enemies. A rigid structure like intervertebral cartilage cannot allow such a flexibility.

HIMADRI KUMAR MOOKERJEE.  
SURYA KANTA DAS.

Department of Zoology,  
University of Calcutta,  
January 18, 1935.

### Stricken Ceylon.

THE outbreak of malaria in a serious epidemic form in apparently healthy parts of Ceylon raises grave scientific problems which concern the public health of not only this island but also of other Eastern countries. The telegrams in the Press report that this scourge has been followed by other diseases such as dysentery and cholera. In the affected provinces, which are not yet free, the total mortality due to all these diseases must be well over 30,000. The situation is worsened by the prevalence of famine.

It seems to us that the enquiry into the causes of such a sudden outbreak of diseases in normally healthy districts, should deal with both the scientific and economic problems of the country. There are numerous species of *Anopheles* in Ceylon and it is unlikely that any one of them or the larger number of them can be held to be responsible for the recent epidemic. We may hazard the hypothesis that the boats calling

at the ports of Ceylon from Singapore in larger numbers within recent times, perhaps may have introduced an exotic species of *Anopheles*, or the Ceylon coolies working in "Singapore Naval Base", may have brought the virulent type of malaria from the Malaya Peninsula. The recent famine must have lowered the resistance capacity of the people, and the pools in the river beds must have furnished the breeding grounds for these Malayan mosquitoes which, swarming round the inhabited areas, spread the disease. Recently a great deal of exploratory work in the jungles, where the ancient kingdoms of Ceylon lie buried, has been in progress, and the workmen catching the infection in these malaria-ridden tracts, may have spread it.

The investigation which is likely to be undertaken, will, we hope, be sufficiently wide in its scope, and the report ought to include constructive proposals for the prevention of recurrence of such epidemics.

## The North Bihar Earthquake, 1934.

A SYMPOSIUM on the origin of the North Bihar Earthquake of January 15th, 1934, was held at a joint meeting of the Mathematics, Physics and Geology Sections of the Indian Science Congress, 1935, under the Chairmanship of Dr. L. L. Fermor. The following is a summary of the speeches.

S. K. BANERJI.

*Meteorological Department.*

The earthquake which occurred in North Bihar on January 15, 1934, had many important peculiarities: it was felt over an area of not less than 3 million square miles—an area which is perhaps greater than that of any previously recorded earthquake. The surface vibrations were felt at greater distances towards the south and west than the north and east, the Himalayas in the north and the Assam and Burma mountains in the east acting as barriers and damping them out considerably.

We find that the energy of this earthquake was slightly greater than  $10^{22}$  ergs. An energy of this order could be produced by the fracture of a quadrangular rock of dimensions not less than 150 km.  $\times$  100 km. and thickness 10 km. This would suggest that the focus of this earthquake must have covered a wide volume and the epicentral track a fairly wide area.

The very great preponderance of surface waves on this earthquake, as well as the type of movements in the preliminary and the secondary phases all suggest that this earthquake had a shallow focus. With this information in our possession, the question arises whether seismology can make any definite contribution to the search for the cause of this earthquake.

It is almost certain that isostatic compensation holds in the case of such large mountains as the Himalayas. For calculation shows that the stress difference required to support mountains of height 10,000 meters above the adjacent valley, in uniform crust, would be about  $10^7$  dynes/cm<sup>2</sup>. This is near the crushing strength of basalt, which could, therefore, just support the Himalayas if the stresses necessary could be distributed over an infinite depth. The Himalayas, apart from being very high, are of such large horizontal extent that they would very probably produce breaking stresses in the lithosphere assumed to be of finite thickness. It is therefore very likely that they are bounded by fault-planes so that they can move up and down independently, that is to say, float on the lithosphere and undergo up and down movements without disturbing the surface crust over the continents. The upward motion of the mountains can, of course, occur as a consequence of denudation and if they are floating more or less independently of the continents the gravity anomalies found in the Gangetic plain and elsewhere are probably not of much importance as undoubtedly the cohesion of the materials forming the continental crust is able to support a small departure from perfect isostasy.

The earthquake occurred on a new-moon day, and on such a day we get a body tide due to the elastic yielding of the solid material of the earth, such that the height of the oceans, as measured by the rise and fall of the sea, relative to the land

is reduced to about  $\frac{2}{3}$  of the true equilibrium height (if the rigidity of earth be assumed to be the same as that of steel). On that day also an atmospheric disturbance was passing over Northern India and Darwin has shown that if the difference of barometric pressure between consecutive regions of "high" and "low" pressures be 5 cm. of mercury and if the centres of 'high' and 'low' be 1500 miles apart, then as a consequence of the yielding of the ground, it will be 9 cm. higher under the barometric depression than under the elevation. These causes could therefore conceivably have served to produce a kind of trigger action.

A simple seismograph in which hydraulic magnification and damping were used and which could be worked near earthquake zones was demonstrated.

S. C. ROY.

*Meteorological Department.*

Dr. Roy stated that a study of the various seismographic records of this earthquake may enable us to deduce the constitution of the outer crust of the earth in Bihar. He estimated the probable thicknesses of the upper and intermediate layers of the crust and from various data calculated the focal depth of the North Bihar shocks to be about 13 km. He said that the focal depth and the thickness of the upper layer suggest that the major failure leading to the disastrous earthquake of January 15th, 1934, occurred near the boundary of the upper and intermediate layers of the earth's crust. A fuller account of Dr. Roy's contribution to this discussion has already appeared in *Current Science*, 1935, 3, 298.

D. N. WADIA.

*Geological Survey of India.*

Among the suggested causes of the recent Bihar earthquake is the one based on the theory of the *underload* of the Bihar plains, due to their being covered by thick alluvial deposits which are about 18% lighter than normal rock. The region extending from Meerut to beyond Dacca has been found by means of gravity measurements to be of great defect of matter, as if this part of India suffers from a lack of some  $\frac{1}{2}$  mile of thickness of rock-deposits. On the two flanks of this belt lie the high Himalaya to the north and the highlands of the Peninsula to the south—areas of overload where the crust supports more than the normal load. These loading anomalies must, under the theory of isostatic balance of all large segments of the earth, cause considerable stress-differences in the earth's crust—stresses which may seek relief in occasional earthquakes. The load anomaly, however, in the present case appears to be too slight (in view of the fact that the Himalaya range is more or less compensated) to be a competent originating cause, though it may operate as a contributory cause. Most of the great earthquakes in other parts of the world have been traced, directly or indirectly, to weak underground structures, such as folds and faults on the strata, which occasionally give way under long continued strains: and it is in the structural plan or architecture of this part of India—which has been the seat of the great majority of recorded

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The load case appears to at the Himalaya to be a compe- may operate of the great he world have to weak under- faults on the way under long structural plan dia—which has ty of recorded

Indian earthquakes since the 14th century—that we should seek for a cause. The underground structure below the plains of Bihar is that of a sunken, trough-shaped basin filled up during late geological times by river alluvia. The floor of this sagged tract is disrupted by several fracture lines, some proved and others hypothetical, but based on collateral evidence, while there is some amount of wrinkling of the strata where the Himalaya joins the plains. The earthquake of January last has proved to be a complex one with 3 distinct epicentra two of which traverse Bihar roughly W.N.W.—E.S.E., parallel with the trend of the Himalayas. One of these is at Khatmandu. But the principal epicentra of the Bihar earthquake, which have given some surprise and uneasiness to Indian geologists and which throw new light on the structure of India, are two well-defined lines to the north and south of the Ganges brought out during the field investigations by the officers of the Geological Survey of India.\* The best marked of these lines is the line from Betiah to Purnea while the third epicentral tract extends from Patna to Monghyr. These tracts are too far south of the Boundary faults and the severe shaking which they experienced must be due to other more or less parallel fault-lines in the floor of the trough between which a block of the sub-crust underneath Bihar subsided. I would, however, mention here that the relatively high destructivity of the quake at places like Monghyr, Jamalpur, Purnea and probably also Khatmandu, was due not to any special focal or nodal seismic intensity, but to the accidental circumstances of their sites, which have produced local exaggeration or intensification of the earth-waves. In the case of Monghyr and Jamalpur, in my opinion, a disastrous intensification of the ground vibrations resulted from the junction of two rock-bodies of quite different elasticities. These cities are built partly on ancient crystalline rock of great rigidity and partly on loose alluvial deposits—the period of vibration of such a rigid rock being quite different from that of the adjacent loosely aggregated alluvium, the elastic recoil of the latter may have produced a destructive rocking of the ground, its amplitude being too great for the old masonry houses. In the case of numerous earthquakes it has been found that the junction-plane of rock bodies of different rigidity is a line of special weakness and destruction. In the case of Purnea the greater destructiveness of the shocks may be ascribed to the weak sub-stratum of the town—a thick bed 60 to 80 feet, of very fine soft sand, of practically no elasticity.

#### AFTERSHOCKS.

All great earthquakes are succeeded by a large number, sometimes several hundreds, of aftershocks and they often throw light upon the direction and extent of the fractures in the crust which originated the principal shock. A record of such shocks during the years 1934 and 1935 is likely to have much significance on the location of the postulated lines of faulting and dislocation underneath the Betiah-Purnea and the Patna-Monghyr epicentra. A careful and continuous record of the aftershocks in areas of great earthquakes has proved of help in studying the main quake which ushered them in. The several thousand after-

shocks of the Assam earthquake of 1897 indicated the courses of the thrust-planes and faults which precipitated that great quake. The shifting of the epicentra of these subsequent minor tremors from point to point and their clustering at certain points provide data for the mapping of the subsidiary and branch-faults associated with the major dislocations of the ground.

#### A PLEA FOR THE ESTABLISHMENT OF MORE SEISMOGRAPHIC STATIONS.

The seismic zone of India possesses but few recording stations and these more often than not fail to produce a complete graph when the intensity exceeds a certain degree or when they are situated at all close to the focus. It would be materially helpful if, say, 8 to 10 recording stations are established between Peshawar and Assam. A seismograph is not necessarily a costly instrument, nor is it necessary that all instruments should be of extreme sensitiveness. Seismographs can be constructed costing from Rs. 500 to Rs. 1,000 and can be easily kept under observation at various University laboratories and periodically visited by a meteorological expert. Such recorders may in course of time collect valuable data for use in demarcating the boundaries of the seismic belt in India. The use of microseisms in locating fault-lines has been lately proved by the Japanese and American seismological laboratories, and the value of obtaining some definite data through these means regarding the course and extent of the faults concealed under the most densely populated parts of India cannot be overestimated.

Seismic recorders can also be utilised to obtain a more definite estimate of the depth of alluvium under the Indo-Gangetic plains and incidentally of the nature of the floor and the existence of any hidden spurs or bluffs of rock, e.g., the one near Monghyr.

W. D. WEST.

#### Geological Survey of India.

It is generally assumed that earthquakes around India are closely associated with faults in the Himalaya or in the rocks beneath the alluvium in front of the Himalaya. But if we consider the two greatest Indian earthquakes prior to the Bihar earthquake, namely, the Assam earthquake of 1897, and the Kangra valley earthquake of 1905, we find that in neither case could it be shown that actual movement had taken place along any known fault. In the absence, therefore, of any direct evidence for connection with faults, it is desirable to look for other possible causes.

The geodetic work of the Survey of India throws interesting light on the underground structure of India. Determinations of the force of gravity and of the deflection of the plumb line in a large number of places in India have revealed an anomalous distribution of crustal density, even after making allowances for the effects of topography, and for the variations in the rocks found on the surface. This led Sir Sidney Burrard to postulate his 'Hidden Range' or area of excess density within the crust, which runs across India in a W.N.W. direction through Jubbulpore. It is followed to the north by a parallel underground 'trough' in which there is a deficiency of density the lowest point of which is beneath the northern slopes of the Himalaya. It has been suggested that this deficiency can be accounted for by the

\* J. B. Auden and A. M. N. Ghosh, *Rec. Geol. Surv. Ind.*, 1934, 68, 177-239.

presence of the light Gangetic alluvium. But there would have to be something like 50,000 feet of alluvium to account for it, and this is extremely improbable. Similarly the high density which is observed further south above the 'Hidden Range' cannot be accounted for by the surface rocks. Moreover, the fact that there is another area of even greater gravity deficiency in Mysore, where the surface rocks are moderately dense—Deccan Trap, metamorphosed sedimentary rocks, and igneous rocks—indicates that these gravity anomalies have no connection with the density of the surface rocks. Recently this problem has been studied in greater detail by Major Glennie, who suggests that the anomalies are due to the buckling of the granitic, basaltic and dunite (or eclogite) layers of the earth's crust.<sup>1</sup> He postulates that there has, for long, been a deep trough or downward warping along the line of the geosyncline of 'Tethys' sea which is known to have existed for a long time, and in which the marine deposits were laid down which eventually gave rise to the present Himalaya on being crumpled. There are, however, two alternative ways of explaining on these lines the phenomena of a continuously sinking geosyncline. We may either assume that the granite-basalt surface, or the basalt-eclogite surface, has buckled up beneath the area of high density, and buckled down beneath the area of low density, as suggested by Glennie; or we may assume that there has been an actual change from basalt to eclogite or *vice versa*. It was long ago pointed out by Dr. L. L. Fermor that basalt and eclogite are rocks having the same chemical composition but different densities, eclogite being composed of minerals, such as garnet, of high density, while basalt is composed of minerals of lower density but similar composition.<sup>2</sup> Such a change might take place with great rapidity, since the change from eclogite to basalt is an exothermic one and so might spread rapidly through a large body of rock which was near the critical point. That some such sudden and deep-seated change could produce an earthquake shock of great intensity has been recently suggested by Oldham.

It is of course fully recognised that the formation of the Himalaya during Tertiary times must have left behind a legacy of unrivalled stresses, stresses which may be continuing to-day, if not in the Himalayas themselves, perhaps in the rocks in front of the Himalayas beneath the alluvium, the relief of which might provide earthquake shocks of great intensity. Whether the Bihar earthquake was due to some sudden deep-seated change of the kind suggested above, or whether it was due to a continuation of the forces which brought the Himalaya into existence, might be decided if the depth of focus of the earthquake could be determined. If it can be shown to be more than, say, 10 kms., then the former hypothesis is more likely to be correct. A lesser depth would indicate a connection with faults in the upper rocks of the crust. Dr. Roy's estimate of 13 kms., if sound, is thus of considerable interest.

This suggestion that the Bihar earthquake (and other earthquakes around India) had a deeper

seated origin than is generally supposed, and that it may have had no connection with faults within the surface rocks is not put forward in any dogmatic way, but merely in order to show that the orthodox view concerning the association of Indian earthquakes with faults in the upper rock may not necessarily be correct. That both the earthquakes and the formation of the Himalayas are manifestations of some change taking place at depth within the earth's crust is perhaps the more correct way of putting it.

C. W. B. NORMAND.

*Meteorological Department.*

Examination of the Indian seismograms recorded during the Bihar earthquake has emphasised anew three needs: (a) additional seismographs of a new type that will record the ground movement during severe earthquakes at distances up to 500 miles from the epicentre; (b) the damping of the pendulum movement of the Omori instruments; and (c) more numerous seismological stations in the neighbourhood of the Himalayan seismic zone. Regarding (a) Dr. Banerji's new instrument is in the experimental stage and promises well but need not deter other physicists from developing other designs. Regarding (c) the instruments at Calcutta, Agra and Dehra Dun ought to be supplemented at least by instruments in upper Assam, Bihar, the north Punjab or Peshawar or Kashmir, and Sind or Baluchistan. Could some colleges assist by the installation of seismological stations in these areas? An added advantage of this from the geophysicist's point of view would lie in the possible divergence of the research activities of a few more physicists in colleges in India towards geophysical studies.

A. C. BANERJI.

*Allahabad University.*

It is now generally recognised that earthquakes are started by fractures in the earth's crust caused by immense stress-difference developed in the layers of the crust. This stress-difference is produced by the unequal cooling of different parts of the earth's crust after solidification. These parts have contracted in volume by different amounts and a state of stress has thus been set up.

It is generally accepted that the surface temperature of the earth has remained constant since solidification. The loss of heat from the surface is balanced by heat generated from radio-active substances. It is found by calculation that a depth of about 20 km. of standard surface rocks containing radio-active substances would keep the surface temperature constant.

As the outer surface of the earth undergoes no further coolings and contraction it is therefore too large to fit the contracted region situated below. There is also an intermediate layer where the contraction is just enough to fit the interior. This is the "level of no strain". The outer loose jacket is therefore under a horizontal crushing stress: crumpling begins at the weakest point and folds are formed. This is the initial stage of mountain-building. Fractures also occur and give rise to earthquakes.

It can be mathematically found out that deformation produces much greater stress difference in thin crusts than in thick crusts. In the

<sup>1</sup> *Survey of India, Professional Paper, 1932, No. 27.*

<sup>2</sup> *Rec. Geol. Surv. Ind., 1913, 43, 41.*



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case of a thin crust, the depressed regions are compressed above and stretched below and the elevated regions are stretched above and compressed below. Moreover maximum stress difference is liable to occur below the greatest elevation and the greatest depression. In the case of the Himalayas there is overloading in the foot-hills and considerable underloading further south in the Gangetic valley, and consequently this great anomaly causes very great stress-difference in this region. If the stress-still further increases, the crust at the point may not be strong enough to sustain it, and fracture may occur to relieve the tension.

It has been suggested that some disturbing extra-terrestrial cause may start the rupture by "trigger action" and that the conjunction of planets may be one such cause.

We find that the cumulative effect of all the planets, even at the time of conjunction, is much smaller compared to the effect produced by either the sun or the moon. So if there be any "trigger" action, it can most possibly be by the combined action of the moon and the sun when their effects are added up at the time of a new moon. In that case more earthquakes should occur at

the time of the new moon than at any other time. But it is doubtful whether lunar periodicity really dominates the occurrence of earthquakes. It has also been suggested that earthquakes are more frequent by night than by day; but available data on this subject does not conclusively prove the above statement. It is also found that the lunar tide in the atmosphere which was first investigated by Chapman has very little effect on the occurrence of earthquakes.

M. N. SAHA.

Allahabad University.

In view of the great area over which this earthquake was felt, it seems unlikely that the focus of the earthquake was shallow as suggested by Dr. S. K. Banerji. Earthquakes which are known to have had a shallow focus, such as the Italian earthquakes, which occur in a volcanic region, although of great intensity at the epicentre, rapidly decreased in intensity away from the epicentre. But the reverse was the case in the Bihar earthquake, and it is likely therefore to have had a deep focus.

## Research Notes.

### Indian Musical Drums.

*The Proceedings of the Indian Academy of Sciences*, 1934, 1, 179 contains a very interesting paper on "The Indian Musical Drums" by Sir C. V. Raman. The value of the paper is very much enhanced by the numerous photographs of the nodal lines of the various modes of vibration of the drum. As the author remarks, the Indian musical drum stands in a class by itself since in it an in-harmonic sequence of notes has been ingeniously converted into a harmonic series, enabling the instrument to be employed in chamber music where ordinary percussion instruments would be intolerable. There are various varieties in the two chief forms, viz., the Mridanga and the Thabla, the first of which is a barrel-shaped instrument with a drum-head on either side, while the second consists of two separate drums one to be played with each hand. The common feature of construction is the contrivance for adjusting the tension of the drum-head equally in all directions: this always consists of sixteen thongs attached at equal intervals round the drum-head, the tension being varied to a nicety either by means of wooden pieces which are struck by a mallet into different positions or in some later forms screws are used to vary the tension. The right hand drum-head is constructed in a peculiar manner, consisting

as it does of three layers of drum-skin which in the final stages are cut out leaving only rings all round excepting for one drum-skin which is loaded in the middle with a firmly adherent composition said to consist of iron oxide, charcoal, starch and gum applied layer by layer so as to give the peculiar loading. The left hand drum-head is somewhat larger and is similarly constructed but without central loading. The note given out by these drums is a sustained one resulting from two features of construction, viz., the heavy wooden shell on which the skin is stretched and the central loading. The gravest mode of vibration is that without interior nodal lines. The second is that having one nodal diameter, the third having two nodal chords dividing the drum into three parts; the fourth has three nodal chords while the fifth has four nodal lines and the drum-head is divided into five parts. These several modes of vibration form a harmonic series. The third harmonic is produced by a combination of the vibration with one nodal circle and that with two nodal diameters. The fourth harmonic is given by the mode with one nodal diameter and one nodal circle or by a mode with three nodal diameters or by a combination of the two modes. The fifth harmonic similarly arises from the mode having four nodal diameters or the

mode having a nodal circle and two nodal diameters. The paper gives details of exciting these various tones and is beautifully illustrated by sand figures formed on the vibrating drum-head.

T. S. S.

#### New Elements beyond Uranium.

SOMETIME ago Fermi and his collaborators reported the results of their experiments on the production of new radioactive elements by bombarding various elements by neutrons. In the case of uranium they obtained a product which showed two main characteristic half-value periods, namely, 13 min. and 90 min. apart from other extremely short-lived (10 secs. and 40 sec.) components. Studying these main components, Fermi and his co-workers showed some evidence to believe that these represented new elements of higher atomic number than uranium. A. V. Grosse repeated their experiments and came to the conclusion that the reactions noted by the Italian scientists were to be attributed to element 91 and not to elements of higher atomic number than uranium. In *Die Naturwissenschaften* (1935, 23, 37) Lise Meitner gives a preliminary account of her investigations regarding the nature of the 13 min. and 90 min. products. Details of the searching chemical analysis to which the products were subjected are given and the conclusion reached that the new products are not representatives of element 91 nor of any other element with lower atomic number. She also gives reasons to believe that the two products are not isotopes but are different elements. The opinion is expressed that the 13 min. product might be element 93 and the 90 min. product element 94. Further details are to be published elsewhere; we await them with interest.

T. S. S.

#### The Carbonyl- or CO- frequency in Raman Spectra.

THE Raman spectra of 69 compounds of type  $X-CO-Y$ , including acid amides, ketones, crotonyl compounds, acid chlorides, urea, phosgene, etc., obtained with the same apparatus, and under almost identical conditions, have been subjected to a systematic study by K. W. F. Kohlrausch and A. Pongratz [*Z. physikal. Ch.* (B), 1934, 27, 176]. A preliminary analysis of the

normal oscillations of a plane symmetrical molecule of type  $X-\overset{\overset{O}{\parallel}}{C}-Y$ , belonging to the symmetry group  $C_{2v}$ , shows that all the modes  $\omega_1$  to  $\omega_6$  are both Raman and infrared active, 5 being in the plane of the molecule. Three of these five are total symmetric ( $\rho < 6/7$ ), and two anti-symmetric ( $\rho = 6/7$ ). With the help of the approximate formula for a valency force system, the observed lines for  $NH_2-CO-NH_2$ ,  $CH_3-CO-CH_3$  and  $Cl-CO-Cl$ , have been identified with these types of oscillations.

This identification of the lines could now be extended to unsymmetrical molecules of type  $X-CO-Y$ , by intrapolation (between  $X-CO-X$  and  $Y-CO-Y$ ), and by extrapolation with progressive changes in  $X$  or  $Y$ . Here, although  $\omega_1$  represents a mode of normal vibration of the whole molecule, it is predominantly determined by the  $C=O$  binding, and can be called the carbonyl or CO frequency. The value of  $\omega_1$  changes from compound to compound and it is shown that these changes are to a considerable degree due to the constitutive influence on the bond strength in  $C=O$ . When the carbonyl frequencies in all the compounds are systematically arranged, as in Table IV, pronounced regularities are observed. In order to obtain a still clearer view of these changes, the CO-frequencies are plotted with frequency as abscissa, and the substituents as ordinates, the scale for the latter being so chosen, that the CO-frequencies for the arbitrary case of  $R-CO-X$ , all lie in a straight line. It is to be expected that these graphs should all be parallel straight lines, if the influences of the groups  $X$  and  $Y$  superpose without any distortion. While this is generally observed, it is not always the case. The deviations from parallelism are, however, in the correct sense, and for the following reason. On the basis of existing information, the influence of the groups can be ascribed to the electrostatic fields due to them. Actually, in the scale adopted here, the groups have roughly arranged themselves in the order of their dipole moments, from the  $-NH_2$  with the highest positive moment at one end to the  $-Cl$  with the highest negative moment at the other. When the signs of the substituents are the same, the mutually induced additional moments in the substituents tend to decrease the original moments and therefore to decrease the influence on  $\omega_1$ . A quantitative consideration of the mechanism

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M. A. G.

### A New Theory of the Glass Electrode.

DOLE was the first to explain the behaviour of the glass electrode in alkaline solutions. Considerations similar to those involved in the formulation of the liquid junction potential led to an equation which well expressed the experimental results. But the interpretation of the constants in the equation was possible only by assuming that  $H^+$  has a mobility  $10^{11}$  times as much as any other ion at the interface. Furthermore, the relative mobility appeared to change with concentration. Gross and Halpern (*J. Chem. Phys.*, 1934, 2, 136) developed a theory based on the general distribution law. Dole (*J. Chem. Phys.*, 1934, 2, 862) has recently applied the quantum statistical theory of electrode processes developed by Gurney, to explain the glass electrode potentials. The equation derived is of the same form as the one derived on the basis of the liquid junction theory; but the constants involved receive a new and a more plausible interpretation. The new theory explains the inability of the anions to affect the potential. A critical review of the experimental data shows how the quantum statistical theory is superior to that of Gross and Halpern. An important feature of the new theory is the quantitative prediction of the temperature variation of the glass electrode potential, data regarding which are lacking at present and are of great interest from the point of view of the theory.

K. S. G. D.

### Surface Films.

THE study of films of organic substances on water has been recognised to be of utmost importance in elucidating the constitution and orientation of molecules on surfaces. Adam's improved type of surface pressure balance for the study of films of the "gaseous" type gives valuable information regarding the structure of the film. The measurement of surface potentials using an "air electrode" of a platinum wire coated with polonium placed above the film, has been extensively used in these studies. Adam and his co-workers have shown in a series of papers that a change in the orientation of molecules at a surface brings about a change in the

surface potential. In a recent paper [*Proc. Roy. Soc. (A)*, 1934, 147, 491] Adam and others have worked with films of the "gaseous" type (Dibasic acid esters, long chain alcohols, aldoximes and ketones).  $\mu$  (the average effective vertical component of the dipole moment of the surface film forming molecules) has been calculated from  $\Delta V$  (the surface potential) using the equation due to Helmholtz

$$\Delta V = 4\pi n\mu$$

where  $n$  is the number of mols. per sq. cm. of the film.

In the case of surface films of substances with two ethyl ester groups  $\mu$  is a constant so long as the films are "gaseous". The  $\mu$  for the ester group is much larger when the molecules lie flat than when standing on end. In the case of alcohols, ketones, etc.,  $\mu$  does not change much during the transition from the expanded to the condensed state, showing that the orientation of the end groups remains unchanged. The end groups are not re-oriented by the restricted oscillations of the chains as a result of the diminished free space available for them on compression.

M. P. V.

### Fungicidal Action of Elements in Relation to their Position in the Periodic System.

In a highly interesting paper on the fungicidal action of elements (*Contr. Boyce Thomson Inst.*, 1934, 6, 4) McCallan and Wilcoxon have compared the toxicity of a large number of compounds with regard to their effect on the germination of fungous spores. The method employed was to determine the concentration of the substance which permits 50 per cent. germination (LD 50) after 20 to 24 hours. Four species of fungi were used, *Sclerotinia americana* (Worm.) Nort. & Ezek., *Botrytis paeoniae* Oud., *Pestalotia stellata* B. & C., and *Uromyces caryophyllinus* (Schr.) Wint. In spite of the several limitations incidental to a study of this character, the elaborate investigations of the authors have indicated several centres of toxicity in the periodic table. With a few exceptions the toxicity within a group increases with increasing atomic weight. The elements of the group yttrium, lanthanum and the rare earths are generally toxic and the more common ones in the group offer promise of a more general use as fungicides. Silver and osmium were the most toxic. The halogens and generally

the more negative elements exhibit wide differences in toxicity depending upon the type of compound tested; while with the more positive elements the same order of toxicity was observed regardless of the compound used. The volatile hydrides so far as tested are all highly toxic; and little toxicity is exhibited by the highly oxidised forms. An element which is highly toxic to one fungus tends to be also toxic to other fungi, a fair degree of correlation having been observed, for the order of toxicity of the different elements with the four fungi studied.

B. N. S.

#### Heavy Minerals in the Tertiary Intrusives of Central Colorado.

In recent times the study of heavy minerals for purposes of stratigraphical correlation is becoming more and more important. J. T. Stark (*Am. Mineralogist*, 19, No. 12) in attempting to correlate the Tertiary intrusives of Central Colorado with the Princeton batholith, has subjected nearly 30 specimens from different localities to mechanical analysis. His table reveals a lack of variety in minerals, these are for the most part made up of apatite, biotite, pyrite, titanite, ilmenite and zircon, which are also the important heavy minerals in the Princeton batholith. The characteristic absence of minerals like tourmaline, fluorite, beryl and sillimanite show that the Tertiary intrusives were particularly poor in mineralisers, and were relatively 'dry' magmas. From these evidences he has confirmed the interpretation of Crawford made on the basis of petrographic studies and field relations that these intrusives must have had a common magmatic source—possibly related to Princeton batholith. From the study of numerous articles on heavy mineral separation and correlation which are so prominently appearing in current journals, it is not too much to expect that it will come in handy for confirming many of the correlations that have already been done on other slender evidences.

#### The Mino-Owari Earthquake of 1892.

In a short note to the *Geological Magazine* (Dec. 1934, 846) Charles Davison, the noted seismologist, has attempted to trace the effects of earthquakes on the condition of strain in the surrounding crustal regions.

In some cases the strain is increased, whereas in other cases the strain is decreased. Such changes on the condition of the strain in the adjacent crust is sufficient in many cases to produce what Oldham has termed 'Sympathetic earthquakes'. This phenomenon has now been studied by Davison in detail in the case of the great Mino-Owari earthquake of 1891. Statistics show that after this great earthquake, in certain of the districts especially in 7 and 13 of Milne's map of Japan, the number of shocks increased suddenly because they are situated on the main fault line. Further by the study of the Milne's charts, Davison has been able to show that the effects of the movement producing 'Sympathetic earthquakes' were confined to within a distance of about 100 miles.

#### The Cytology of the Alimentary Canal of *Periplaneta*.

R. A. R. GRESSON has described (*Q.J.M.S.*, December 1934, 77, Part II, No. 306) the form and distribution of the cytoplasmic inclusions and their relationship to the secretory granules in the epithelial cells of the midgut and hepatic caeca of *Periplaneta orientalis*. Functionally the hepatic caeca and the anterior region of the midgut are chiefly secretory while the posterior part of the midgut is main absorptive. In the anterior part of the midgut the periods of secretion alternate with the periods of absorption. Both the Golgi bodies and the mitochondria in the secretory as well as the absorptive cells are described with reference to their topographical relations to other organs of the cell and also to their shape. The author suggests that the secretory material is separated under the influence of mitochondria and in the vicinity of the nucleus is used in the formation of the secretory granules under the influence of the Golgi bodies.

#### The Arterial System of the Common Indian Rat Snake.

HARISH CHANDRA RAY (*Journ. of Morph.*, December 1934, 56, No. 3), has given a detailed account of the arterial system of *Ptyas mucosus* and has recorded certain interesting features. The author has noticed for the first time the origin of the oesophageal artery from the left systemic arch, the presence of two longitudinal trunks on



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either side of the hepatic portal vein and the formation of a peculiar looped chain. A separate splenic artery and the presence of a complicated arterial circuit in connection

with the female reproductive organ and a pair of small arteries called "the arteria complexa" are the other interesting features of this form.

## Science Notes.

*A Study of the Atmospheric Horizontal Visibility at Bangalore.*—By A. Ananthapadmanabha Rao (*Science Notes of the Ind. Met. Dept.*, 1934, 5, No. 60). Visibility observations taken at Bangalore during a period of two years at 8, 10, 12 and 16 hours have been analysed and the monthly, seasonal and annual variations of visibility frequencies have been determined. Visibility is generally fair to good; bad visibility is a rare occurrence except in the mornings, when it is largely associated with mist, fog or haze; the frequency of bad visibility is greatest in winter and summer reaching a maximum in March, and is least in the South-West Monsoon with a minimum in August. A study of the association of bad visibility with relative humidity, wind velocity, wind direction and Cumulus or Cumulo-Nimbus clouds, shows that:—(1) bad visibility is a minimum with values of relative humidity between 61 and 80 per cent.; (2) frequency of bad visibility decreases with increase in the velocity of the surface-wind; (3) bad visibility is most frequent with southerly winds and least frequent with northerly winds; and (4) bad visibility is less frequent in the presence of Cumulus or Cumulo-Nimbus clouds than in their absence.

*The nature and germination of seeds of Tinospora cordifolia Miers.*—Messrs. S. L. Ajrekar and J. D. Oza of the Gujarat College, Ahmedabad, write: "With reference to the note on fruit and seed development in *Tinospora cordifolia* Miers, without fertilisation and embryo formation published by A. C. Joshi and V. V. Raman Rao (*Curr. Sci.*, 1: 34, 3, 62) and the subsequent note on Exembryonate seeds by B. Sahni (*Curr. Sci.*, 1934, 3, 109) it may be of interest to record that in the course of an investigation of the fungus parasites of *Tinospora cordifolia* Miers, which we have been carrying out at Ahmedabad we have had occasion to raise seedlings of this plant for inoculation experiments and we have found that the seeds have a normal embryo and the germination is also perfectly normal.

The non-formation of an embryo noted by Joshi and Rao is probably only due to the absence of pollination. This point can be easily settled by them by artificial pollination. The question of the germination of the exembryonate seeds can also be answered by them by actual trial.

The development of "barren" fruit without the stimulus even of pollination is a familiar phenomenon in cultivated plants, e.g., in Fig, Cucumber, Grape.

*A note on seed variations in Carica papaya, Linn.*—Mr. S. A. Parandekar, M.Sc., Rajaram College, Kolhapur, writes under date 9-2-1935: "The usual experience of many of us is that the mature fruit of Papaw (*Carica papaya*) contains numerous black seeds filling up as it were the cavity of the fruit. All these seeds are very

nearly alike. Very interesting types of variations in the sizes and the number of these mature ovules have been observed.

"In one of the ripe fruits only two seeds of the usual form and size were found. In another fruit belonging to the same plant only one ovule of an abnormal size (about  $\frac{1}{2}$ ") and of a yellowish colour was found. This could not in any way be differentiated into the parts of a seed. The micropyle was wide open and the integuments prominently seen. A naked eye examination of the longitudinal section, however, failed to show any differentiation in the nucellar tissue which simply represented a large mass of cells; in a third fruit of the same plant an ovule of the type mentioned above was present in addition to a few (about 10) normal seeds."

*Rare Observation of a Plant drawing Nourishment from Eggs.*—Mr. A. Ramakrishna Reddy, B.Sc. (Hons.), of the Annamalai University, reports a rare observation concerning a well-developed grass plant of the genus *Cyperus* in the University grounds whose roots had pierced three developing *calotes* eggs lying at different levels. Apparently the plant was drawing its nutrition from them. The plant had also developed adventitious roots in the lower and middle eggs, both of which had shrivelled down owing to their being depleted of the contents. The observer considers this to be a case of semi-parasitism or a rare and unusual instance of a plant developing a carnivorous habit through the root system.

*Map-making in India.*—From the first attempts at Map making made by the Merchant Adventurers of old to the rigorous methods of surveying introduced first by Col. Lambton (1800-1823) and extended and improved by Col. Sir George Everest (1830-1843), the history of Indian surveys is one of evolutionary progress. The first map of India appears to have been prepared by the French Geographer D'Anville from a knowledge derived by the routes of travellers in India and rough charts of the coasts; the English Edition of this was published in 1764.

The credit for laying the real foundation of Indian Geography goes to Major James Rennell (1763-1782) who as Surveyor-General of Bengal carried out systematic route surveys, the specified stations being located by means of astronomical observations of longitude and latitude. The Bengal Atlas published in 1781 was the result of his labours. About the year 1800, Major Lambton, who realised the inaccuracy of the older methods, put up proposals for carrying out a scientific trigonometrical survey. The work of covering the whole of India with a grid of accurately measured triangles has been continued ever since, and the credit of planning and mapping of India on a really scientific basis goes to Lambton. His able successor Sir George Everest started

on the completion of the Great Meridional Arc series of triangles which had been brought up from Cape Comorin to Sironj in the centre of India, and was to terminate in the Himalayas near Mussoorie. Up till 1843 he was employed in extending his system of a gridiron of triangulation in the series about 60 miles apart which was opposed to Lambton's scheme of a network. The whole conception of the basis of land surveying in India, as it now exists, is due to the creative genius of Sir George Everest (1830-1843).

*Third International Congress of Soil Science.*—The Third International Congress of Soil Science will be held in Oxford, England, from July 30th to August 7th this year under the presidency of Sir John Russell, D.Sc., F.R.S. The two previous congresses of the series were held in Washington in 1927 and in Leningrad and Moscow in 1930, and were notable for the exceptionally international character of the personnel and the discussions. The Congress will meet as a whole in six plenary sessions, at which a general survey of recent advances in every branch of soil science will be made, and it will also work in sections or "Commissions" dealing specifically with soil physics (I), chemistry (II), biology (III), fertility (IV), classification (IV) and technology (VI). Three sub-Commissions will discuss problems relating to alkali, forest, and peat soils respectively. A 16-days excursion round Great Britain leaving Oxford immediately after the Congress, and terminating in Cambridge on August 23rd is being arranged for the benefit of members wishing to obtain first hand knowledge of British agriculture and soils.

Every member of the Congress will receive a copy of the Official Transactions, including the full text of papers read at the plenary sessions, and detailed reports of the discussions at the Commission sessions. The cost of the Transactions will be included in the Congress fee (£2), payment of which will also entitle members to attend all meetings, receptions, etc., held in connection with the Congress. Accommodation during the Congress in an Oxford College may be reserved through the Organising Committee, or privately in hotels or boarding houses.

Intimation of attendance at the Congress should be sent as soon as possible to the Secretary of the Organising Committee, Mr. G. V. Jacks, Imperial Bureau of Soil Science, Harpenden, England, from whom all further information may be obtained.

*Fourth International Fertilisers' Conference.*—We are happy to announce that Prof. N. R. Dhar, D.Sc. (London and Paris), F.I.C., I.E.S., Professor of Chemistry, University of Allahabad, has been appointed National Correspondent for India of the Fourth International Conference which will be held at Rome in 1936. Prof. Dhar has accepted the office and will be proceeding to Rome next year. This International Organisation has branches all over the world and the National Correspondents are expected to report to the Conference the Agricultural Progress of the Country which they represent. Dr. Franco Angelini, Member of the Italian Parliament, is the Secretary of the Conference.

*New Oil Seeds Research Station in Madras.*—

About fifteen acres of land were leased in 1925 for research on groundnuts. In 1930, Government sanctioned the mobilisation of a separate section for research on important oil seeds, viz. Groundnuts, Gingelly, Castors and Cocoanuts. The increased work demanded a larger station but there were no possibilities for extending the existing station, and it was therefore decided to open a new station about a mile and six furlongs away from Tindivanam (South Arcot District) in the heart of the groundnut area. The new station is about fifty acres in extent with possibilities for expansion, if necessary. A sum of about Rs. 25,000 is sanctioned for the purchase of land, necessary equipment and construction of residential buildings. The Imperial Council of Agricultural Research has sanctioned a scheme costing about Rs. 50,000 for research on oil seeds in Madras. The research work proposed under this scheme will be conducted on this station. Genetical, physiological and agronomic problems connected with groundnuts, gingelly and castors will mainly be dealt with at this station.

The Academic Council of the Aligarh Muslim University has decided to award the degree of Doctor of Philosophy—the first Doctorate given in Physics by the University—to Mr. Muhammad Zaki Uddin, M.Sc. Hons. (Alig.), Research Scholar of the Aligarh Muslim University.

*Indian Central Cotton Committee.*—The 30th meeting of the Indian Central Cotton Committee was held on the 4th and 5th February 1935, at the headquarters of the Committee at Vulcan House, Nicol Road, Ballard Estate, under the presidency of Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research.

Among the more important subjects that came up for consideration may be mentioned a reference from the International Federation of Master Cotton Spinners' and Manufacturers' Associations suggesting a reversion to the original system of marking bales on hoops; complaint from the Lancashire Indian Cotton Committee regarding the mixing of different types of cotton; report of the Publicity and Propaganda Officer; findings of the Special Meeting of the Agricultural Research Sub-Committee on the schemes of the Committee; spread of Garrow Hill or Deorwada cotton in Berar; the establishment of cotton markets in the Bombay Presidency and the Punjab and the reports of Sub-Committees.

The Committee adopted the report of the Agricultural Research Sub-Committee. The Madras Pempheres and Physiological Scheme was examined in detail and its continuance agreed to.

The Madras Herbaceum Scheme was extended for a further period of three years for the further testing of promising strains. The Punjab Root Rot Scheme, the Punjab Botanical Scheme and the Punjab Spraying Trials Scheme were extended for various periods. A new scheme known as the Mysore 'Red Leaf Blight' Scheme was sanctioned for three years with a grant of Rs. 2,814 per annum. The Sub-Committee also recommended that the existing arrangement for subsidising the Hubli and Gadag Co-operative Societies be

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**Chronica Botanica—International Year-Book of Botany.**—This work which is expected to be published in the Spring of 1935 embodies several important sections: (1) Calendar—important dates connected with the History of Botany and the activities of the well-known Botanists. (2) The International Botanical Congress—Announcements, Reports of Proceedings, etc. (3) International Societies, Committees, Congresses, etc. (4) Survey of Pure and Applied Botany during the preceding year. This section will contain personal information about botanists in every part of the world and also annual reports of all botanical institutions including laboratories, museums, herbaria, experimental and other stations for applied botany. The nature of the more important investigations being carried on in these institutions will also be indicated. (5) Correspondence. This "Forum Botanicum" will provide opportunities for ventilating the views on all subjects of interest to botanists. (6) Advertisements. This Year-Book is edited by Fr. Verdroon in collaboration with an Advisory Board and numerous assistant and corresponding Editors. Further information can be obtained from Fr. Verdroon, Botanica, P.O. Box 8, Leiden, Holland.

**Association of Economic Biologists.**—5th January 1935:—Dr. R. D. Rege, Crop Physiologist, Padegon, gave a lecture on the "Problems of the Deccan Canal Tract".

At the annual meeting of the Association on the 23rd January 1935, the following office-bearers were elected: Mr. K. Ramiah, M.Sc., Paddy Specialist to the Government of Madras, *President*; Mr. V. Ramanathan, L.A.G., Cotton Specialist to the Government of Madras, *Vice-President*; and Dr. J. S. Patel, M.Sc. Ph.D., Oil Seeds Specialist to the Government of Madras, *Secretary*. The resolutions were passed, opposing the removal of valuable Botanical specimens from this country. The Retiring President, Mr. N. L. Dutt, Second Sugarcane Breeder, Imperial Cane Breeding Station, Coimbatore, delivered a very able address on "Recent advances in Sugarcane Breeding in India" illustrated with lantern slides.

28th January 1935:—Dr. J. A. Daji, Officer in charge of Soil Research, Sholapur, delivered a lecture on the "Decomposition of the green manure in soils".

**Indian Botanical Society.**—At the annual meeting of the Indian Botanical Society held at Calcutta on January 4th, 1935, the following office-bearers were elected.

*President* (1 year): Dr. J. H. Mitter, M.A., Ph.D., F.L.S.; *Vice-Presidents* (1 year): Prof. P. Parija, M.A., I.E.S.; Dr. S. R. Bose, M.A., D.Sc., F.L.S., F.R.S.E.; *Honorary Secretary* (3 years): Dr. E. K. Janaki Ammal, M.A., M.Sc., D.Sc., F.L.S.; *Members of the Executive Council* (1 year): (1) Dr. B. Sahni, M.A., D.Sc., Sc.D., F.G.S., F.A.S.B.; (2) Dr. P. C. Sarbadhikari, M.A., Ph.D., D.Sc., D.L.C.; (3) Dr. P. Maheshwari, M.Sc., D.Sc.; (4) Dr. T. Ekam-beram, M.A., Ph.D. (5) Dr. M. A. Sampath-kumaran, Ph.D.; (6) Prof. R. H. Dastur, M.Sc., F.L.S.; (7) Dr. S. P. Agharkar, M.A., Ph.D., F.L.S.; (8) Dr. K. C. Mehta, M.Sc., Ph.D.; (9) Dr. K. Bagchee, M.Sc., D.Sc., D.L.C.; (10) Mr. K. Biswas, M.A. Particulars regarding membership may be

obtained from the Secretary, Dr. E. K. Janaki Ammal, M.A., D.Sc., Imperial Sugarcane Station, Lawley Road P. O., Coimbatore. Subscriptions for membership should be sent to the Treasurer and Business Manager, Prof. M. O. Parthasarathi Iyengar, M.A., Ph.D., F.L.S., Director, University Botany Laboratories, Teynampet, Madras.

**Biochemical Society, Calcutta.**—A meeting of the Biochemical Society, Calcutta, was held on Wednesday, the 30th January, at the School of Tropical Medicine at 4-45 p.m. Dr. N. R. Chatterjee *et al* read a paper on "The effect of bacteriophage on the enzyme activity of vibrio cholerae" and Dr. B. C. Guha and Mr. A. R. Ghosh read a paper on "The biological synthesis of ascorbic acid (Vitamin C)."

The Executive Council of the Lucknow University has nominated Dr. Birbal Sahni of the Lucknow University as delegate to the third centenary celebrations of the Natural History Museum, Paris, which is being held about the last week of June 1935. Dr. Birbal Sahni will also represent the Lucknow University at the International Botanical Congress which is being held at Amsterdam in September 1935.

**Proceedings of the Association of Economic Biologists, Coimbatore, Vol. I, 1930-33.**—This little pamphlet of about 100 pages contains an account of the transactions of the Association since the date of its inception in 1930. The activities of the Journal which were being recorded from time to time in the pages of the *Madras Agricultural Journal* have now been brought together within the covers of one volume in chronological sequence. The pamphlet represents a useful collection of abstracts of papers and lectures and since a good number of the observations communicated in abstract form does not appear to have been published as full scientific papers in any of the scientific Journals, this publication will form the only record of such observations. It is a matter for the publishers to consider whether in subsequent publications, it would not serve a more useful purpose if the contributions are grouped together under crop heads rather than arranging them in chronological sequence. Such an array will form a record of the progress of research under classified subjects. The abstracts, too, could be made fuller so as to include significant data.

We are very happy to congratulate Dr. H. Chaudhuri, Ph.D., D.L.C., on his appointment as the Head of the Department of Botany Teaching in the University of the Punjab. The mantle of the late Rai Bahadur Shiv Ram Kashyap has fallen on worthy shoulders and we look forward for further progress in the department which has already a great reputation as research and teaching centre in India.

We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 49, No. 8.

"Journal of Agriculture and Live-stock in India," Vol. 4, Pt. VI.

"The Journal of the Royal Society of Arts," Vol. 83, No. 4287.

"Indian Journal of Agricultural Science," Vol. 4, Pt. VI.

"Contributions from Boyce Thomson Institute," Vol. 6, No. 4, Oct.-Dec. 1934.

"American Journal of Botany," Vol. 21, No. 10.

"The Journal of Institute of Brewing," Vol. 41, No. 1, Jan. 1935 and Supplementary Number containing title page, contents, Index, 1934, Vol. 40.

"Canadian Journal of Research," Vol. 2, No. 6.

"Chemical Age," Vol. 31, Nos. 808-809; Vol. 32, Nos. 810-812.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 67, No. 13, Vol. 68, No. 1.

"Journal of Indian Chemical Society," Vol. 11, No. 12.

"Indian Forester," Vol. 61, No. 1.

"Forschungen und Fortschritte," 11, Jahrgang, Nos. 1-3.

"Forest Bulletin, No. 87, 1934 (Silviculture Series) Von Wulff's Yield Tables for Teak Plantations in Java," by H. G. Champian.

"Forest Bulletin, No. 89, 1934. The Effect of Defoliation on the Increment of Teak Saplings," by H. G. Champian.

"Agricultural Statistics for India," Vol. 2, 1931-32. Area, Classification of area, Area under irrigation, Area under crops, Live-stock and Land Revenue assessment in certain Indian States.

"Transactions of the Mining and Geological Institute of India," Vol. 29, Pt. 3, December 1934.

"Indian Trade Review," Vol. 13, Nos. 73 to 74.

Department of Commercial Intelligence and Statistics in India—Statistical abstract for British

India with Statistics where available relating to certain Indian States from 1922-23 to 1931-32.

Lanolin Rust Preventers (2nd Edition). Issued by the Department of Scientific and Industrial Research, Engineering Research Special Report No. 12. (H. M. Stationery Office, 1934.)

National Research Council, Canada, 17th Annual Report containing the report of the President and Financial Statement, 1933-34.

"Medico-Surgical Suggestions," Vol. 3, No. 12, Vol. 4, No. 1.

India Meteorological Department, Scientific Notes, Vol. 5, No. 60. A study of the Atmospheric Horizontal Visibility at Bangalore.

"Journal of the Indian Mathematical Society," Vol. 1, No. 3.

"Nagpur Agricultural College Magazine," Vol. 9, No. 2.

"Nature," Vol. 134, Nos. 3399 to 3400; Vol. 135, Nos. 3401 to 3403.

"The Journal of Nutrition," Vol. 8, No. 6.

"The Journal of Chemical Physics," Vol. 2, Nos. 11 and 12; Vol. 3, No. 1.

"Journal de Chimie Physique," Tome 31, No. 9.

"Physica," Vol. 2, No. 1, January 1935.

"Science Progress," Vol. 29, No. 115.

"The Indian Trade Journal," Vol. 155, No. 1499; Vol. 116, Nos. 1491 to 1493.

Imperial Institute of Veterinary Research, Annual Report, 1934.

#### CATALOGUES.

Bailliere Tindall & Cox.—Publications in Medicine and Sciences, October, 1934.

Cambridge University Press, Cambridge Springs Books, January to July 1935.

### Academies.

#### National Institute of Sciences of India.

At the first ordinary general meeting of the National Institute of Sciences of India held in the rooms of the Asiatic Society of Bengal, 1, Park Street, Calcutta, at 11 a.m. on the 8th January 1935, the papers mentioned below were read:

- (i) "Synopsis of the Pre-Vindhyan Geology of Rajputana," by Dr. A. M. Heron, D.Sc., F.R.S.E.
- (ii) "Physiology, Bionomics and Evolution of the Air-Breathing Fishes of India," by Dr. S. L. Hora, D.Sc., F.R.S.E., F.A.S.B.
- (iii) "Problems of the Solar Corona," by Prof. M. N. Saha, D.Sc., F.R.S., F.A.S.B.
- (iv) Ionospheric Height Measurements at Allahabad," by Mr. G. R. Toshniwal (communicated by Prof. M. N. Saha).
- (v) "On the Electron Theory of Metals," by Dr. R. C. Majumdar, Ph.D., University of Lahore (communicated by Prof. M. N. Saha).
- (vi) "On Symmetrical Space with Minimum rate of expansion," by Prof. N. R. Sen.
- (vii) "New facts regarding infection of Citrus by *Colletotrichum gleosporoides*," by Dr. H. Chaudhuri, Lahore.
- (viii) "Synthetic Enzyme," by Prof. H. K. Sen and Mr. Sobhanlal Banerji.
- (ix) On the question of the Expansibility of Zero in the series of Legendre functions having non-integral parameters," by Prof. Ganesh

Prasad. (x) "On the Cataphoretic Speed and Inorganic Colloids," by Prof. J. N. Mukherjee, Mr. S. G. Chaudhuri and Mr. B. N. Ghosh.

(xi) "On Mon and Munda in India and beyond," by Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.A.S.B., I.C.S.

Physiology, Bionomics and Evolution of the Air-Breathing Fishes of India. By Dr. S. L. Hora, Zoological Survey of India.—The fresh-water fishes of ponds, pools and marshes in this country, as in the tropics generally, are subjected, as a result of the marked periodicity of the dry and wet seasons, to extreme conditions of drought for prolonged periods. The shallow waters become very foul and are often liable to complete desiccation. As a result a number of fishes have adapted themselves to aerial respiration, so that the deficiency in the oxygen contents of the water does not affect their lives to any very great extent.

The fresh-water air-breathing fishes of Bengal have been extensively studied since 1830 and have been the subject of considerable experimental work. Fishes kept in aquaria and prevented from coming to the surface to breathe air were "drowned" in the earlier experiments, but if a larger vessel is employed or the water is kept



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thoroughly aerated, "drowning" does not occur in the majority of cases. Fishes like *magur* (*Clarias*) and *singi* (*Heteropneustes*) can live indefinitely under water provided suitable conditions for life are established. In *koi* (*Anabas*) and *saul* and *lata* (*Ophicephalus*) the air-chambers are in the form of cavities in the head so that when these fishes are subjected to "drowning" experiments, a certain amount of air is locked up in the chambers and the fishes die of asphyxiation. If, however, this air is squeezed out and replaced by water in some way, the fishes can live under water indefinitely provided the water is kept well aerated.

*Cuchia* (*Amphipneus*) is a highly specialised fish in which regular "lung-like" chambers are developed for breathing air. This specialisation makes it impossible for the fish to live indefinitely under water.

In the dry season, hill-streams become cut up into series of pools in which the oxygen content of the water falls considerably as compared with that of rushing torrents. Here again the fishes are forced at times to resort to aerial respiration.

In tidal creeks of the estuaries and of the seashore, the tide plays an important part in the lives of certain fishes, specially the shore-living gobies and blennies. At times they are immersed under water and breathe by means of their gills, while at other times they are left high and dry and at such times they must resort to aerial respiration.

It is thus seen that in India the evolution of air-breathing fishes has taken place in four different habitats: (i) Marshes and ponds, (ii) Hill-streams, (iii) Estuaries, and (iv) Sea-shores. The habit of breathing air seems to have been acquired independently by groups of species living under different environmental conditions and it seems that while the simplicity of a structure is no criterion of its low organization or primitive nature, its utility appears to be the sole guiding principle in its evolution.

Dr. B. Prashad mentioned that he had watched Dr. Hora's experiments, which were carried out in the laboratories of the Zoological Survey of India, and had made such suggestions as had occurred to him at the time. He added that Dr. Hora's results are faithful records of his observations and mark a considerable advance on our knowledge of the physiology of respiration of the air-breathing fishes of India. Dr. Hora's suggestions regarding the mode of origin of the air-breathing habit in the fishes of different habitats offer a very promising field for further work and it is hoped that future workers will try to elucidate the various factors operating in these habitats more precisely.

Professor P. R. Awati enquired if the author had done any work on the vascular system of the air-breathing fishes so as to correlate the structural adaptations with consequential modification in the blood supply to the respiratory organs. In reply Dr. S. L. Hora referred Professor Awati to a number of works already published on the vascular supply of these fishes and added that further morphological work is, at his suggestion, being carried out at Cambridge and Lucknow to amplify the author's experimental results.

## Indian Academy of Sciences.

The Sixth Scientific Meeting of the Indian Academy of Sciences was held on the 26th January at the Indian Institute of Science, Bangalore. Sir C. V. Raman, Kt., F.R.S., N.L., the President of the Academy, was in the Chair. 43 scientific papers representing various branches of science and communicated by scientists from all parts of the country were listed for discussion.

The following papers have been published in the 7th Number of the Proceedings.

### SECTION A.

S. BHAGAVANTAM AND A. VEERABHADRA RAO: *Distribution of Intensity in the Rotational Raman Spectra of Gases*.—The relation between the apparently different types of intensity distribution in the rotational Raman Spectra of Liquids and Gases is experimentally followed up by compressing  $N_2O$  and  $CO_2$  at temperatures below their critical point. The absence of a maximum in the rotational wing and concentration of intensity in the close neighbourhood of the Rayleigh line which are regarded as specially characteristic of the liquid state, are now also observed in gases, although at high pressures. M. RAMANADHAM: *The Principal Optical Polarizabilities of the Naphthalene Molecule*.—A new method of evaluating the optic moments of a molecule based on a knowledge of the orientation of the molecules and the refractive indices in the crystalline state, is presented. THE LATE A. N. MELDRUM AND P. H. PARIKH: *Synthesis of Phenylacetic acids from Gallic acid and its Methyl ethers*. THE LATE A. N. MELDRUM AND P. H. PARIKH: *Synthesis of m-Hemipinic acid*.—A new synthesis starting from veratric acid is described. AZHAR ALI KHAN, P. N. KURIEN AND K. C. PANDYA: *The Condensation of Aldehydes with Malonic acid in the presence of Organic Bases. Part II. The Condensation of Salicylaldehyde*.—The effects of a number of organic bases other than pyridine and piperidine such as lutidine, quinoline, cinchonine, etc., are quantitatively studied. K. VENKATACHALIENGAR: *The method of finding the class-number and the structure of the class group of any algebraic field*. I. CHOWLA: *The representation of a Positive Integer as a Sum of Squares of Primes*. S. L. MALURKAR: *Effect of variation on the Transmission of Temperature Discontinuity*. B. RAMAMURTI: *Linear Complexes related to a Rational Norm Curve*.

### SECTION B.

HARI RAMAN BHARGAVA: *Contribution to the Morphology of Eciptia erecta Linn.* B. M. JOHRI: *Studies in the Family Alismaceae. II. Sagittaria sagittifolia L.* COL. I. FROILANO DE MELLO: *A Contribution to the Study of the Blood Parasites of some Indian Birds*.—The following parasites of Indian birds found in Goa are described or recorded:—(1) *Herodias intermedius* Wagler: a *Giardia* abundant also in the intestine and which will be described later on; *Plasmodium herodiadis* n. sp.; *Hæmoproteus* n. sp. ?; a *Microfilarium*. (2) *Gallinula chloropus* L. *Plasmodium gallinula* n. sp. (3) *Macholophus xanthogenys* (Vigors): *Hæmoproteus macholophi* (Plimmer, 1912). (4) *Chloropsis aurifrons davidsoni* Baker: *Plasmodium chloropsidis* (Scott, 1925); *Leucocytozoon chloropsidis* n. sp.; a *Microfilarium*. S. S. PATWARDHAN: *On the Structure and Mechanism of the Gastric*

*Mill in Decapoda. II.*—A Comparative account of the Gastric Mill in Brachyura.—The gastric mill is essentially typical in all cases of Brachyura examined. S. S. PATWARDHAN: *Nematodes from the Common Wall-Lizard Hemidactylus flavoviridis (Ruppel)*.—Examination of the intestines of several specimens of the common wall-lizard *Hemidactylus flavoviridis* (Ruppel) revealed the presence of two species of Nematodes: (1) *Thubunia asymmetrica* (Baylis, 1930); and (2) *Thelandros hemidactylus* sp. nov. a new species of the genus *Thelandros* Wedl. 1862. C. R. HARIHARA IYER, G. S. SIDDAPPA AND V. SUBRAH-

MANYAN: *Investigations on the Rôle of Organic matter in Plant Nutrition, Part VI. Effect of minute quantities of certain forms of organic matter on plant growth and reproduction.*—Injection of minute quantities of certain organic extracts into mature sunflower plants led to not only better growth but also greatly increased flowering and seeding. The best results were obtained in the case of plants receiving extracts of yeast or farmyard manure. Comparative trials with inorganic salts which were fed directly to pot or plot cultured French beans or barley did not lead to any marked improvement.

### Heavy Water in Chemistry.

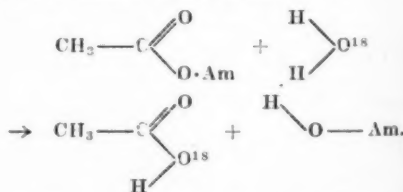
IN a lucid exposition before the Royal Institution, Prof. M. Polanyi (*Nature*, **135**, 19) points out that the new isotope of hydrogen is viewed so differently from other isotopes that some chemists consider its discovery to be possibly the greatest advance in chemistry made in this century. In fact this structural isotope does not behave as an isotope at all and can be separated from the normal hydrogen by chemical means. In general, compounds of heavy hydrogen (D) react more slowly than the corresponding ordinary hydrogen (H) compounds, heavy water reacting 20 times more slowly. These differences cannot be sufficiently accounted for as a mass effect. The compounds of the two hydrogens differ actually in their energy content, and this can be explained according to the Law of Uncertainty, a principle of Nature recently discovered by Heisenberg. According to this, every molecule has a kind of permanent energy called the "uncertainty energy", and it can be calculated that for ordinary water the energy is 13,097 cal., while for heavy water it is only 9527 cal. Thus ordinary water requires a much smaller quantity of energy to split it into hydrogen and oxygen than does heavy water. This permanent energy is greater the tighter the bond which holds the atoms in position and the corresponding contrast between the two hydrogen compounds also becomes more marked. The consequence is that D prefers to exchange places with H wherever it is more tightly bound, with a resulting release of some energy as in



Such interchange reactions have been the object of numerous studies in recent years. According to the relative preference which a compound gives to D over H, a

rather intimate knowledge of the permanent energies in the compounds is obtained. Further, this capacity of some compounds to accumulate a comparatively higher quota of D present in a mixture, can be utilised to work out a cheaper method of manufacturing pure D<sub>2</sub>. The interchange reaction can be used to prepare more complicated compounds of heavy hydrogen, such as C<sub>6</sub>D<sub>6</sub>. It also throws a considerable light on the mechanism of chemical reactions, such as hydrogenation. Again, it may be possible to utilise the lowered reactivity in synthetic chemistry as hydrogen compounds which ordinarily are readily oxidised or otherwise decomposed,—might become more stable if H is replaced by D.

Heavy isotopes of other important elements, such as O<sup>18</sup>, N<sup>15</sup>, and C<sup>13</sup> can also be made similarly useful. Thus, the hydrolysis of amyl acetate with water containing H<sub>2</sub>O<sup>18</sup> and examination of the OH of the resulting alcohol showed that the oxygen in the alcohol does not come from the water used in the saponification and the actual reaction mechanism is



It is likely that the greatest stimulus of all will be given to the chemistry of living matter when such labelled carbon, hydrogen, oxygen and nitrogen atoms will become more generally available.

M. A. G.

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## Industrial Outlook.

### The Industrial Manufacture of Absolute Alcohol—I.

By Jean Caupin,

Engineer, The Mysore Sugar Co., Ltd., Mandya.

IT is well known that absolute alcohol cannot be obtained by mere distillation even from its very strong aqueous solution although the most efficient still-heads are employed, the reason for this being that alcohol and water form an azeotropic mixture which behaves like a pure liquid and is more volatile than pure alcohol. The constant-boiling

on a large scale owing to poor yields and high cost of the drying agent. The most successful industrial methods are based on the valuable observations of Sydney Young<sup>1</sup> and his collaborators, the data obtained by whom are given in Table I.

Sydney Young discovered that when a mixture of equal weights of benzene and

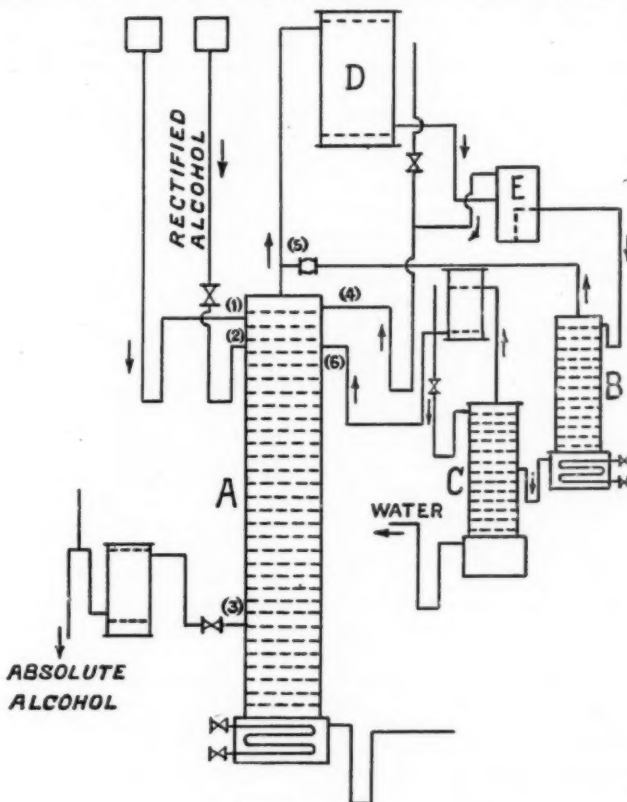


Fig. 1.

mixture contains about 4.5 per cent. of water (Table I). The usual laboratory methods of preparing small quantities of absolute alcohol by treatment of dilute alcohol with solid drying agents like lime, calcium chloride, calcium carbide, calcium metal or potassium carbonate are uneconomic when practised

95 per cent. alcohol are distilled, a ternary azeotropic mixture containing alcohol, benzene and water is formed, this mixture being more volatile and also richer in water

<sup>1</sup> Distillation Principles and Processes, 1922, p. 179.

TABLE I.

*Boiling Points and Percentage Composition of Alcohol, Benzene and Water Mixtures.*  
(A=Alcohol. B=Benzene. W=Water.)

Liquid	Boiling pt.	Percentage Composition		
		A.	B.	W.
W ..	100			
B ..	80.2			
A ..	78.3			
<i>Mixtures :</i>				
A-W ..	78.15	95.57	..	4.43
B-W ..	69.25	..	91.17	8.83
A-B ..	68.24	32.36	67.64	..
A-B-W ..	64.86	18.5	74.1	7.4

than the alcohol-water mixture. It is therefore possible to expel all the water from 95 per cent. alcohol by adding to it a suitable quantity of benzene and carrying out a fractional distillation. During the distillation, there is a tendency towards formation of three fractions, all the water and benzene and some alcohol going over in the first two fractions, while the third fraction or residue consists of anhydrous alcohol. The distillate separates into two layers, the upper layer forming roughly 85 per cent. of the total volume. The composition of the two layers is as given below in Table II.

TABLE II.<sup>2</sup>

	Water	Benzene	Alcohol
Upper Layer ..	0.5	84.5	15.0
Lower Layer ..	32.0	11.6	56.4

With the help of the above introduction it will be easy to visualise the large-scale plant shown in Fig. 1, and its operation. Rectified alcohol is conveyed by the pipe (2) to the top of the distilling column A which is heated by a steam coil at the base. The binary azeotropic mixture which is formed fills the top of the column and flows back into it from the condenser. Benzene is now introduced gradually (pipe 1) in order to form the ternary mixture until the temperature in the middle of the column falls by 2-3° in the process. The column being thus prepared for dehydration the rectified alcohol is now fed continuously into

it. Part of the liquid condensed in cooler D is sent to the separator E where it separates into two layers having the composition shown in Table II. The upper layer which is rich in benzene is sent back to the main column in order to form more of the ternary mixture while the lower layer flows into the subsidiary column B where the benzene in it is removed as the ternary mixture and transferred to column A. The dilute alcohol flowing from the base of column B is introduced into the rectifying column C, where it is resolved into 95.5 per cent. alcohol which is conveyed to the main column A. The water separated at the base of the column is thrown out of the system. In the main column A itself the dilute alcohol descends from plate to plate and parts with its water to benzene which carries it away to the top of the column. Anhydrous alcohol completely freed from benzene accumulates in the base of the column and is drawn off by a syphon device.

Some technical details regarding the process will not be out of place in this article in view of the fact that the Mysore Sugar Co. Ltd., Mandya, are erecting a plant supplied by the French firm who have arrangements with the owners of the patent rights, the "Usines de Melle", for manufacture of the required plant. The said firm, *viz.*, "Ateliers Pingris and Mollet-Fontaine à Lille, France" have erected several plants in various parts of Europe including Germany. More than a hundred millions of gallons of absolute alcohol are being prepared every year by this process, one particular factory having a capacity of 40,000 gallons of absolute alcohol per day.

Several modifications of the plant are available to operate it to produce (1) liquors like arrack and rum for human consumption, (2) rectified spirits, or (3) absolute alcohol.

The question of the production of industrial alcohol for purposes of power-raising has received considerable attention in recent years owing to the enormous quantities of molasses available in sugar factories, which, unless utilised, threaten to paralyse the sugar industry. Considering the low price of the molasses and the efficient processes available for manufacture of absolute alcohol, one can expect to see a Power-Alcohol industry firmly established in India in the near future.

The author will be pleased to furnish additional information on any points of obscurity either in the technical or industrial aspects presented in this paper.

<sup>2</sup> Guinot, *Chime and Industrie*, 1926, 15, 325.



Reviews.

UNE NOUVELLE CONCEPTION DE LA LUMIERE.  
By Louis de Broglie. (Hermann et cie, Paris.)  
Pp. 48. 12 Francs.

This monograph deals with a new theory of light by M. de Broglie. Presenting an outline of the theory of the corpuscle of Dirac, he has examined the electromagnetic operators, the potential and the field attached to it. Then he has postulated that the photon exists as a corpuscle of Dirac obeying the Wave Equation. He shows thereby that the photon is made up of two elementary corpuscles with a spin  $\frac{h}{4\pi}$  for each and obeying the Bose-Einstein Statistics. A very interesting feature of de Broglie's 'demi-photon' is that its rest mass is not rigorously zero (as in his old theory) but is of the order  $10^{-44}$  gms., i.e.,  $10^{10}$  times smaller than that of the electron.

N. S. N.

ATOMIC THEORY AND THE DESCRIPTION OF NATURE: Four Essays, with an Introductory Survey. By Niels Bohr. (Cambridge University Press, 1934.) Pp. 119. Price 6s.

We have in the book before us a collection of four essays by Niels Bohr with an introductory survey which serves to emphasise the unity of thought running through the several essays. These essays appeared at different times in different journals and each served to orient physical thought and lead it to fresh conquests. The present collection thus helps us to have a glimpse into the forces which resulted in the extraordinary developments of Quantum and Wave Mechanics.

The first essay is an elaboration of a lecture delivered in August 1925 before the Scandinavian Mathematical Congress at Copenhagen and stresses the Mathematical methods used in the development of Quantum Physics. The second is expanded from a paper read before the Como International Congress of Physicists in 1927 and lays emphasis on the indeterminacy principle and the complementarity of the wave and particle pictures. The third was published in 1929 as a contribution to a pamphlet issued to commemorate the jubilee of Planck's doctorate and emphasises the subjective character of our perceptions and inferences. The fourth article is developed from a lecture delivered before the Scandinavian Meeting of Natural Scientists in 1929 and considers

the relation between the concepts evolved from a study of inanimate Nature and those necessary to understand the phenomena of life. In this last essay Bohr shows that the indeterminacy which crops up when extremely small-scale atomic phenomena are studied may be characteristic of the processes of life itself. Bohr has been at the head of the younger school of physicists who have decided that causality has to be sacrificed in order to have a rational description of Nature and we see in these essays a masterly exposition of this viewpoint. The articles also give a survey of the development of modern quantum theory with a keen analysis of the implications of these developments. The publishers deserve thanks for making these essays available to a larger public.

T. S. S.

INTRODUCTION TO MECHANICS AND HEAT.  
By Nathaniel H. Frank, sc.D. (McGraw-Hill Book Company, Inc.) Pp. xiv + 339. Price 18s.

The book is an attempt to develop a unified treatment of Mechanics, Acoustics and Heat. A logical development starting with the dynamics of a particle, leading up to that of a rigid body and a system of particles occupies the first twelve chapters. The treatment is detailed, and includes a study of such topics as simple harmonic motion, the pendulum, gyroscopic motion, and gravitational motion, as also the principles of statics. Vector concepts are freely used and elementary calculus employed wherever needed. Chapter XIII on Hydrostatics includes a short treatment of surface tension and Chapter XIV on Fluid Dynamics a similar short treatment of viscosity and flow through pipes. A concise treatment of elasticity in Chapter XV is followed by acoustics in Chapter XVI under the suggestive title "Dynamics of Elasticity". The rest of the book, Chapters XVII-XXII are devoted to Heat, and deal with heat conduction, the thermodynamics and kinetic theory of a gas, properties of real gases and the laws of thermodynamics.

The whole subject-matter is dealt with purely on the theoretical side, and no attempt has been made to deal with or describe the experimental side. The treatment is lucid, and the book is eminently calculated to give a consistent and logical theoretical grounding

in the main principles of the subjects dealt with to a pass degree standard. A feature is the number of examples worked out and the large list of problems given at the end of most of the chapters.

A. V. T.

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**TORSIONAL VIBRATION, ELEMENTARY THEORY AND DESIGN CALCULATIONS.** By W. A. Tuplin, M.Sc. (Chapman & Hall, Ltd., London.) Pp. xviii+320. Price 21s.

This is a book of very great interest to the mechanical engineer who has to deal with the design of shafts for the transmission of power, whether in automobiles, aeroplanes or ships, where power is either communicated to or absorbed from the shaft periodically and the transmitting system is capable of torsional vibrations. It is obvious that under these conditions dangerous oscillations involving high stresses in the materials of the shaft may arise leading to breakdown. That a whole book should be devoted to what may appear at first sight a very narrow branch of Physics shows the degree of importance which such topics often assume to the technician.

The subject-matter is dealt with in a very practical manner both on the theoretical side and in its applications. Chapters I, V and IX deal with the basic theory of torsional vibrations, solutions of numerical equations and the harmonic analysis of periodic torques respectively. The rest of the Chapters I-X take up the problems of free and forced vibrations of shafts loaded with single, double and multiple masses, in a progressive manner with a wealth of illustrations and numerical calculations. Chapters XI-XIII deal with the critical speeds of such systems, their resonance under periodic fluctuations of torque, the resulting stresses and methods of damping such systems to avoid dangerous stresses being set up. The rest of the book deals with such special subjects as geared systems, heavy shafts, couplings and impulsive torques.

A bibliography containing 28 references, a two-page index and a table explaining the symbols used to designate the several physical quantities involved with the units adopted for measuring them, are noticeable features. The get-up of the book is very good.

A. V. T.

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**THEORY OF ALTERNATING CURRENT WAVE FORMS.** By Philip Kemp. (Volume I in "Monographs on Electrical Engineering"

Series published by H. P. Young.) (Chapman & Hall, Limited, 1934.) Pp. ix+218. Price 15s. net.

The advances in electrical engineering within recent years have been so rapid that literature on many subjects has lagged considerably behind knowledge on these subjects and one has to wade through a mass of matter scattered in the technical literature to get a comprehensive idea of these subjects. Therefore the publication of the "Series of Monographs on Electrical Engineering" of which the present book is the first volume is very much to be welcomed.

The book begins with a comprehensive treatment of the properties of complex wave-forms in which their effect on impedance, resonance conditions, power, power factor, form factor, etc., have been clearly explained. This is followed by wave and ripple filters, polar diagrams, and power and energy cyclograms. The very interesting subject of the effect of iron has been dealt with in a separate chapter followed by another chapter on cyclically varying resistances, areas and pulsating reactance and capacitance as sources of harmonics. Harmonics in poly-phase systems have been treated in a separate chapter, but in view of its extreme practical importance one would have liked to see an ampler treatment of this subject. The book ends with a chapter on the various methods of harmonic analysis. No mention has been made of transients. In view of its great importance, particularly in transmission line work, the inclusion of a chapter on surges would have considerably increased the value of this book.

The book should be equally useful to the advanced student and the engineer and its companion volume on "Alternating Current Wave Forms in Practice" by the same author, which is in preparation, will be looked forward to with interest by the reader of the present volume.

F. N. M.

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**AUTOMATIC PROTECTION OF A.C. CIRCUITS.** By G. W. Stubbings. (Chapman & Hall, Ltd., London.) Pp. 293. Price 15s.

Recent practice in the distribution of Electricity has been effected through a network of distribution system so that the least possible delay occurs in restoring service during interruptions and also that almost all the consumers have the chances of alternative supply and interruptions are reduced to a minimum. Even in the high tension

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transmission line, several stations are being tied together to ensure continuity of supply. The above procedure has brought in a number of interesting problems with regard to the protection to be afforded for various distribution centres as well as the generating stations thus inter-linked with the result that various kinds of protective relays have been developed and the distribution and station Engineer should have a thorough knowledge of these relays and their operation to correctly synchronise them so that they function accurately to the best advantage of the engineer, machinery and the consumer. The function of these relays is entirely dependent upon the instrument transformers which are the source of supply of energy to these relays and these transformers are of a special nature and should possess special characteristics to be of efficient service.

In the above book which has been very lucidly written the author has made a sincere attempt to explain the essential points and the characteristics of these transformers to enable the reader to grasp correctly their functions and thereby understand the functions of the relays connected therewith. Even though the book may not be titled as a treatise on all the types of relays developed recently, it certainly gives a fairly good idea of the various types and the duties that each apparatus and particularly the characteristics of each kind of relay have been brought out very well to enable any engineer to follow their functions and utilise them to his best advantage. The explanations have been narrative as well as Mathematical just enough to indicate their functions and are, I believe, within the understanding of an ordinary engineer.

M. H.

CLINICAL AND PATHOLOGICAL APPLICATIONS OF SPECTRUM ANALYSIS. With Notes on Spectrography in Chemistry and Mineralogy, and Tables for Qualitative Analysis; being the Authorised Translation of Part II of *Die Chemische Emissionsspektralanalyse*, by Dr. Walther Gerlach and Dr. Werner Gerlach. Translated by Joyce Hilger Twyman. (145 pp. Royal 8vo., 52 Illustrations, bound in cloth boards. January 1935.) 14s. 6d. nett. 15s. post free.

Messrs. Adam Hilger, Ltd., in pursuance of their dual rôle as producers of spectrographic apparatus and disseminators of spectro-analytical information, have added to the series of text-books that they publish,

a translation of Part II of *Die Chemische Emissionsspektralanalyse* by Walther and Werner Gerlach. The authors form a combination especially suitable to the work covered by the book, the one an eminent physicist who of late years has devoted intensive study to spectro-chemical analysis, the other a professor of pathological anatomy. Together they have applied to the difficult problems of pathology, the powerful means of attack provided by spectrography. Such diverse subjects are treated as the distribution of metals in the body with particular reference to therapeutic uses of heavy metals; the deposit of metals on flesh or clothing by electric discharge (as in electrocution) and the analysis of bullets, and the traces of metals left by bullets throughout the various portions of the path of a bullet wound. The application of spectroscopy of special chemical problems is also discussed. Not the least valuable section of the book consists of tables in which are given not only the most sensitive spectrum lines for the determination of various metals, but also lines of other metals with which they might be confused in the analysis of given substances, and guidance as to the avoidance of such difficulties. The technique of spectro-chemical analysis has extended into many branches of technology in the last few years, and this account of its use in a comparatively fresh field promises great help in some difficult problems of pathology, and clinical and forensic medicine.

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AN INTRODUCTION TO INORGANIC CHEMISTRY. By Satya Prakash, D.Sc., Lecturer in Chemistry, University of Allahabad. (Kala Press, Allahabad.) Pp. 478. Price Rs. 6.

This book is meant to cover the syllabus in 'Inorganic Chemistry' for the B.Sc. degree of Indian Universities and to be read in conjunction with a text-book for the Intermediate classes.

While one very much appreciates the references to the mineral resources and industries of this country, the elaborate and sometimes unimportant details of output of ores, cost, etc., seem to be superfluous in a text-book of this kind.

The summaries in the form of comparative statements at the end of every chapter, indicating the methods of preparation of different compounds are a special feature.

Manufacturing processes of a number of important compounds have not been dealt

with in any detail: the methods of manufacture of substances like Sodium carbonate, Sodium hydroxide, Ammonia, Sulphuric acid (contact process) have been disposed of in a few sentences.

While the modern trend both in teaching and writing of text-books aims at co-ordinating inorganic and theoretical chemistry, it is surprising to find the author deliberately excluding all physical chemistry. The physico-chemical principles involved in technical reactions, *e.g.*, the synthesis of Ammonia, the manufacture of Nitric acid from air, have not been explained. The ionic theory, the law of mass action, and Le Chatelier's principles as applied to inorganic reactions find no mention. One looks in vain for at least a passing reference to topics like corrosion, passivity, Werner's view on co-ordination compounds and theories of catalysis which have always found a place in standard books on Inorganic Chemistry.

The method of presentation of facts is not satisfactory. The printing and get-up of the volume leave much to be desired. Typographical errors abound. Very few diagrams are given and these are poorly drawn.

As one who has been teaching the B.Sc. classes for several years the reviewer feels that there is not much to commend in the book.

M. SESHAIYENGAR.

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**THE CHEMISTRY OF PETROLEUM DERIVATIVES.** By Carleton Ellis. (The Chemical Catalogue Company, New York.) Price \$ 18.

The author begins in the introduction by saying "World production of petroleum is approaching a quarter of a billion tons annually but, with new deposits constantly being found—indicative of the widespread distribution of oil throughout the land and under the sea—the apprehensions of a decade ago that the supply of this essential raw material would soon be exhausted no longer obtain." Again some exponents of petroleum technology have expressed the opinion that the large number of hydrocarbons present in the petroleum oil-wells in almost inexhaustible quantity should lead to industries to yield new substances which should compare favourably in their variety and utility to civilisation with the numerous useful products obtained from coal tar. The realisation of this dream has been hindered, as the author says, from a significant difference between the two groups of hydrocarbons,

from coal tar and from crude petroleum, that the chemical individuals of the form are comparatively easily separable from one another; whereas, the hydrocarbons present in petroleum oil are, in the main, indifferent to the usual conversion reagent besides there is the possibility of an aliphatic hydrocarbon of one definite composition existing in an extraordinarily large number of isomeric forms rendering the task of individual separation immensely difficult. It can be cited as an illustration that a hydrocarbon containing 20 carbon atoms can exist in as many as 3395964 isomeric forms including stereo-isomers.

Although as the result of the impetus received from the researches of some veteran workers in this field, greatly improved refining procedures and efficient methods for the isolation of individuals have been discovered and progress towards 'quantity preparation' of pure compounds rendered rapid, it has not been possible yet to make the chemistry of petroleum as useful, scientifically and industrially, as could be desired commensurate with the vastness of deposits. Happily, however, past few years have witnessed the accumulation of a vast amount of research materials on this subject and an enormous growth in the number of investigators in this field.

This present volume covers 1,285 pages and the subject-matter has been grouped in 50 different well-arranged chapters including most up-to-date informations about petroleum technology and an elaborate treatment of the chemistry and utility of the derivatives of petroleum and a very useful author and subject index. Every effort has been made by the author to give references to most published material including the large amount of patent literature both of scientific and industrial interest. The book besides furnishing the reader with a fund of information bearing both on the industrial and the scientific aspect of the subject will, it is expected, greatly stimulate thought for further research, thus eminently fulfilling the high purpose of the author.

Carleton Ellis, one of the greatest authorities on this subject and in whose laboratory work of far-reaching importance on petroleum has been in progress for some years, took up the task of collecting and collating the widely diffused literature on this problem including the results obtained in his own laboratory, and by presenting this volume has rendered yeoman service to scientific



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P. C. GUHA.

REPORT OF THE FUEL RESEARCH BOARD FOR THE YEAR ENDING 31ST MARCH 1934. (Published by H. M. Stationery Office, November 1934.) Pp. vii+178. Price 3s. net.

The above is a valuable document presenting a detailed account of the progress made by the Fuel Research Board in problems relating to the combustion of raw coal or its conversion into other forms of fuel.

The first section of the report relates to a survey of the coal resources of the country. The information obtained by the survey has been very valuable and has enabled colliery authorities to make modifications of working which increase the efficiency of the pits or improve the quality of coal as marketed.

The report then draws attention to the increased demand for small coal of which over 77 million tons are being annually cleaned by either washing or dry processes. Small coal has gained in popularity and is finding extensive use not only for domestic purposes but also in industries.

Carbonisation of coal is now being investigated on works scale at the Fuel Research Station. Researches on the extraction of motor spirit and fuel oils from coal are also in active progress. The lighter fractions of tar together with the spirit 'scrubbed' from gas produced by carbonisation provide an excellent motor spirit of which 40 million gallons are being produced annually in Great Britain. The motor spirit has already been tried by the Royal Air Force with very satisfactory results. Large quantities of the fuel oil have also been taken up by the Royal Navy. In addition to the above, the possibilities of obtaining mineral oil from tar is also being investigated, a process of hydrogenation at high pressure (upto 400 atmos.) and temperature (upto 250° C.) being tried. Some new problems have arisen in the direct hydrogenation of coal and a systematic study of the influence of inorganic constituents of coal on the rate of hydrogenation is in progress and is expected to yield useful results. Researches are also in progress to determine the efficiency of burning pulverised coal in boilers with small combustion spaces. Three new types of fuel burners have been devised. One of these, the 'Grid' burner is already being manufactured by one commercial firm. Another prominent line of enquiry is the

manufacture of motor spirit from rubber. Under favourable conditions of temperature and pressure, rubber is readily amenable to hydrogenation and a yield of motor spirit corresponding to about 50 per cent. of the weight of the original rubber is obtained. Under other conditions a pale yellow viscous oil can also be obtained. If rubber can be obtained at a low price, it should be possible to manufacture motor spirit and lubricating oil out of it with comparative ease.

The above report is an interesting instance to show how organised co-operative research on a large scale can yield highly fruitful results. India has also a supply of coal as also an area under rubber which could be greatly increased if more use could be found for that product. In view of the importance of liquid fuel in the industrial advancement of the country, it is hoped that the above report will engage the attention of the Central Government and will eventually lead to the inauguration of an organised scheme of research that will yield useful results in the near future.

LANOLIN RUST PREVENTERS. Second Edition. By C. Jakeman. Engineering Research Special Report No. 12. Pp. iv + 26. Department of Scientific and Industrial Research. (H. M. Stationery Office, London.) Price 6d. net.

The second edition of this interesting report is a valuable contribution to the problem of the rust prevention of steel plant and machinery during storage. The tests which extended over a period of five years have been carried out under a variety of exacting conditions, so that the encouraging results reported with the Lanolin compositions recommended, may be accepted with confidence. Benzene has been found to be the best solvent for lanolin and to deposit the best protective coating. Oil soluble dyes are recommended for incorporation with lanolin compositions so that one can easily spot the parts not coated.

In spite of the excellent results obtained with lanolin and its superiority over other classes of reputed rust preventers, it is admitted that it does not provide a "universal panacea" for corrosion. Occasional failures have occurred and no explanation can be offered in the present stage of investigation. It is significant that such failures have been recorded with coatings on hardened steel and it may be worthwhile to investigate the protective capacity of lanolin

compositions in relation to the composition of steel under test.

The report gives practical details of preparing lanolin compositions, preparation of surfaces for their application and describes methods of successful application to ensure uniformity of protective coating. This highly useful pamphlet will be gratefully welcomed by those interested in the protection of steel plant and machinery.

M. S.

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EVERYDAY BOTANY. By L. J. F. Brimble, B.Sc. (Lond. and Reading). (Macmillan & Co., Ltd.) Pp. 589. Price 7s. 6d.

The book is intended primarily for the use of pupils studying for the School Certificate and Matriculation examinations and also as an introduction to the subject for students, who wish to take up later on Medicine, Pharmacy, Forestry, Horticulture and Agriculture.

There are 23 chapters covering practically all the aspects of Botany, namely, morphology, histology, physiology, ecology, evolution, heredity and classification of plants. The book is written in easy and readable style and profusely and well illustrated. Practical exercises are given at the end of each chapter, which greatly add to the value of the book.

The author, in this book, has attempted to treat Botany by dealing with the applications of plants in daily life, while at the same time giving a general account of the subject

to meet the requirements of the examinations. The structure and functions of the several parts of plants are dealt with and at every stage the practical applications of these in every-day life are referred to then and there. The treatment of the book is quite logical on the whole. But the author has taken up too wide a field by attempting to give information regarding the utilitarian side of all aspects of plant life with the result that he is forced to be very cursory (evidently owing to lack of space) in his treatment of practically every aspect of the subject, both academical and utilitarian. As a result only brief references to structures and functions of the several parts of plants are given without any attempt at a detailed explanation of them. The same defect is seen while the author was dealing with the several applications also of plant life. The pupils will, therefore, get only a very superficial idea of all these aspects. We are afraid that a pupil trying to obtain a knowledge of Botany with the aid of this book *alone* will not get a proper grounding in the subject. If he has a general elementary knowledge of the subject already from class teaching or from some other text-book, then he will find the book very useful for supplementary reading.

The book, however, will be found very useful to teachers, who will find in it plenty of suggestions regarding the applied sides of Botany, which they could with profit incorporate in their class teaching.

### Forthcoming Events.

ELECTRICAL ENGINEERING SOCIETY, BANGALORE.

(The Meetings will be held at the Indian Institute of Science at 3 p.m.)

March 6th. "Economical Design of Transformers." By Mr. M. V. Keshava Rao, B.Sc.

March 13th. "Recent Trends in Insulator Manufacture." By Mr. N. V. Raghunath, B.A., B.E., ASSOC. AMER. I.E.E.

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